# RAILWAY ENGINEERING
## AND MAINTENANCE OF WAY.
BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

Vol. VI | *Chicago* | JULY, 1910 | *New York* | No. 7



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## Subaquous Concrete Work

(Continued.)

The face mould is shown in place, in this sketch, with its loading ballast and lower layer of concrete in process of filling in. The ram is in highest position, the box being ready to receive its supply, about 12 cubic feet, from the hopper. It will be noted that the strain on the ram arm is taken by a wire cable, operated with block and tackle by means of a winch from the frame above the mixer. A part of the frame is omitted from the sketch in order to show the measuring car. The other illustrations will show the operating details more clearly.

Ram and Guide.—It will be remembered that one of the problems of this undertaking was to place the concrete between the old masonry wall and the forms for the concrete facing without clogging up the space near the top, and thus creating voids at the bottom of the wall. Had the thickness of the new wall been greater, or the surface of the old masonry wall, or the bank, been smoother, this difficulty would not have occurred. As a matter of fact, as results proved, there were places where the ram was not required.

Plate C shows the details of the ram and guide. In most of the work the guide was maintained at an angle of 45 degrees, but it could be adjusted to work nearer the vertical if required. The ram frame was made of timber, and the guide of 15-inch steel channels. The latter was carried in a gudgeon bearing attached to the inclined post support, which may be seen in Plate B. The ram and box would drop by gravity, and was drawn back or controlled by a steel cable operated from the hoist. The illustrations will give a more complete idea of the entire plant and the method of operation.

The Plant in Operation.—The entire plant was ready for work early in June, 1907. In April the canal was unwatered for a portion of the month and gangs of men put on to prepare the slope wall, on the south side, for the new facing. All the loose stones were removed and the toe of the wall made ready to receive the bottom of the mould. Photographs were taken of any sections presenting unusual irregularities, and all the necessary data provided as to the condition and slope of the bank.

Placing the Moulds.—The first section was started on the south bank, a few hundred feet above the Cote St. Paul bridge, a location which, in so far as agitation of the water and limitation of working room were concerned, was the worst possible. The moulds were floated opposite the site, raised up by the slings with the lifting derrick, and lowered down in front of the bank. The diver then descended and checked the distance from the wall to the mould, guided the rail-ballast to place, and saw the toe properly braced with large flat stones lowered down for that purpose. The top of the mould was placed in alignment by setting off the given distance from the base line. In some places the top of the bank or revetment wall was so badly washed that it was not possible to take a line from it. The top of the mould was secured to the bank by timber braces and cables to anchor blocks placed at convenient points.

Operating the Ram.—After the moulds were ready, the mixing scow was floated into place, the arm run out over the bank and moored at rest over the longitudinal beams arranged to slide it forward on, when the scow was moved. (See illustration.) Tests were now made in lowering and raising the ram, and, beyond the usual stiffness expected in new machinery, everything worked satisfactorily.

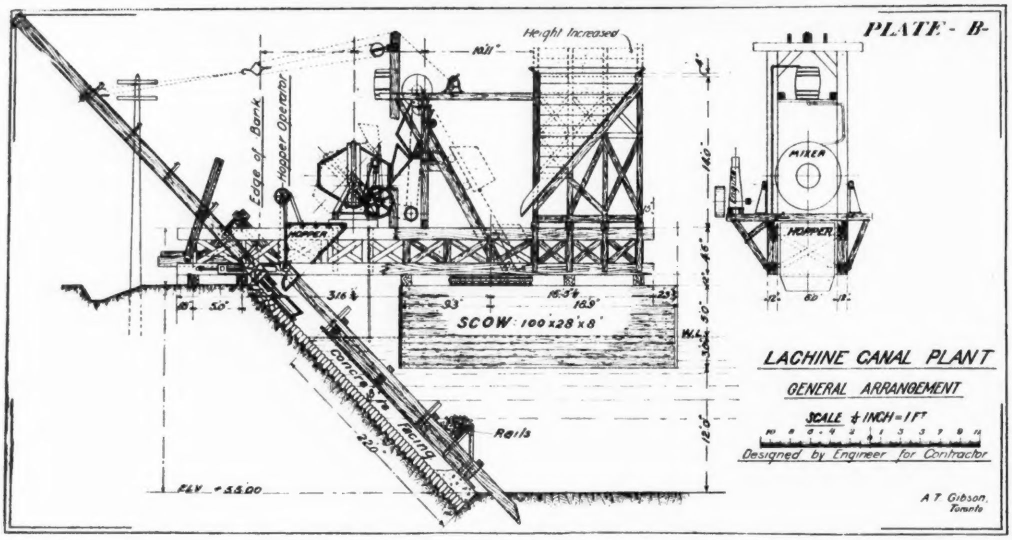
A few batches of concrete were next tried, and it was noticed, as the bucket was lowered, that the water which rushed in at the top caused no violent washing out of the cement. After a little experience in lowering the ram, no discoloration of the water appeared, which showed that the cement was not being washed away. The ram was run to the bottom, about 23 feet on the slope, and, as the concrete filled in below, it was found quite easy to judge the proper point at which to stop the ram. This operation was continued until the top was reached, and a section of about 20 feet, at bottom, was filled before the plant was moved forward. The scow was moved about every 8 or 10 feet as the work progressed. When the concrete reached to within 4 or 5 feet of the top of the wall it was found unnecessary to use the ram, and the concrete was allowed to flow into place from the open bucket. The accompanying illustration gives an excellent view of the ram and the method of blocking it up.

Concrete Ingredients and Mixing.—The clause of the specification governing the above was as follows:

"Concrete Ingredients.—The concrete shall be made in the proportions of one barrel of cement, three barrels of sand, and six barrels of crushed stone, or in such other proportions as may be ordered by the engineer in charge.

"The sand (provided by the contractor) shall be coarse-grained, sharp, and silicious, free from earthy or vegetable matter. A sample of the sand which the contractor wishes to provide must be furnished to the superintending engineer before any is brought on the work. The stone ballast (provided by the contractor) shall be crushed hard grey limestone, or 'banc-rouge,' crushed to pass through a two-inch ring. The run of the crusher shall be used, and the crushed material must be transported and stored so that no earthy or foreign matter of any kind is intermixed.

"All dirty or unsuitable materials shall be removed from the site of the work as soon as ordered by the engineer in charge.




"Concrete Mixing.—The concrete shall be mixed by machine only, except at isolated points, where hand-mixing may be allowed.

"A Smith mixer, or other approved rotary mixer, shall be used, and each batch of concrete, of the proportions stated in paragraph 5, shall be turned for at least two minutes at the regular speed of the mixer, and continuously, until it is required for the work.

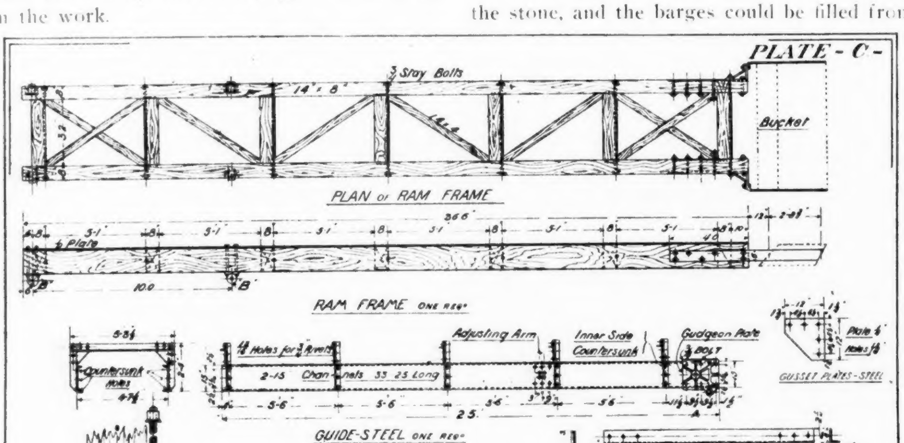
"No concrete shall be allowed to stand until the initial set has started before it is placed in the wall, and any loss of concrete, caused by the setting of the cement owing to slowness of handling, or by spilling due to careless handling, is to be borne by the contractors, who shall also pay for the cement used in each batch of concrete thus lost, etc."

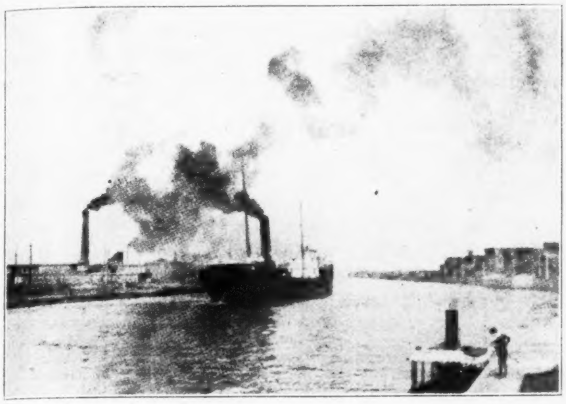
This proportion was usually adhered to, except that a slight variation was made with any change in the sand or the stone provided. The usual mix was about 30 cubic feet of stone, measured loose, 13 cubic feet of sand, and 4½ to 5 bags of cement. This rarely exceeded a yard of concrete when settled in the work.

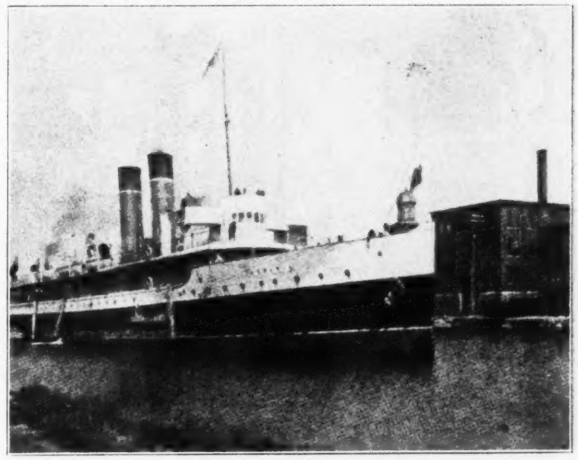
The sand was usually from the lake of the Two Mountains, one grade, A, being largely retained on the 50 and 80 sieves, the other, B, being considerably coarser. The latter was chiefly used. For the sake of comparison with sands used in other places, the following table, taken from tests made by the author, will prove of interest. The samples in each case were taken from the sands used on various works at the places named. The results are the average of a number of tests.

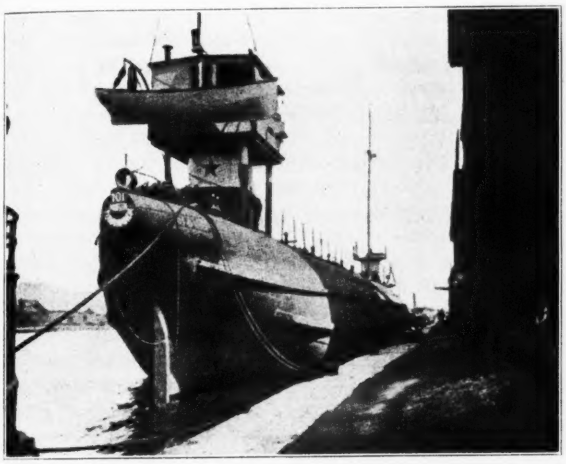
The crushed stone used was what is called Potsdam quartz, or Laurentian sandstone. It is hard, creamy white, gritty stone, apparently somewhat porous, but possessing an ideal surface for cement to cling to. The contractors for the work opened up a special quarry at Ile Perrot, where they erected an extensive storage bin, with automatic chutes, and were thus enabled to land the material on the work without delays and at a minimum of expense.

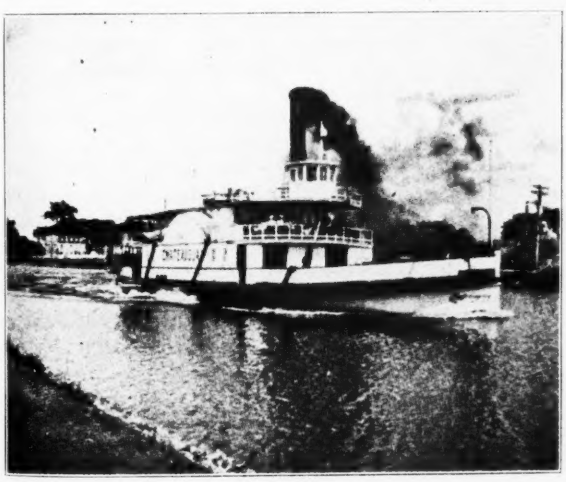
Barges holding about 200 tons were employed to carry the stone, and the barges could be filled from the bin direct











Types of Vessels Using the Canal.

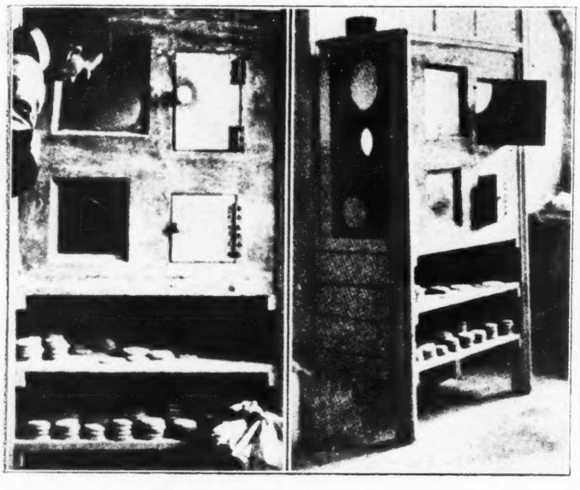
SAND TESTS—SIFTING.

| Name of Sand. | Per cent retained on sieves, Nos. 100 | 80 | 50 | 30 | 20 | 10 | 6 |
|---|---|---|---|---|---|---|---|
| Montreal Sample A.... | | 36 | 49 | 8 | 6 | 1 | |
| " " B.... | 28 | 21 | 23 | 15 | 12 | 1 | |
| Hull .................. | | 19 | 58 | 17 | 6 | | |
| Toronto, Pit .......... | | 26 | 22 | 18 | 24 | 10 | |
| Halifax ............... | 2 | 7 | 16 | 9 | 17 | 12 | 37 |
| St. John .............. | 5 | 18 | 40 | 19 | 14 | 2 | 2 |
| Winnipeg .............. | 2 | 6 | 14 | 11 | 25 | 13 | 29 |
| Vancouver ............. | 2 | 8 | 24 | 12 | 29 | 15 | 10 |

in about twelve minutes. The haul was about 24 miles. The run of the crusher was always used, as is demanded by all of the Lachine canal specifications for crushed stone for concrete ballast, the maximum size being about 2 inches. Our experience is that, with probably one exception—viz., a hard, brittle limestone—the run of the crusher, without screening, gives a broken stone that will make the best concrete.

The maximum size of the stone specified is two inches. At times, however, with the Potsdam quartz, flat pieces, longer than two inches, passed through the crusher, and at first were rejected, but after an examination of the wall, it was found that these larger size stones gave a good bond to the mass, especially when worked near the front and at an angle to the wall. The benefit of these long pieces was seen when the wall was examined during the unwatering the following April. At the water-line, where any wash occurred from the waves caused by passing steamers, the larger stones projected into the mass sufficiently to prevent the ballast from becoming loosened and falling down. In fact, these projecting pieces could not be moved, even with a hammer blow.

Cement.—Selecting the cement proved a little more difficult than in ordinary work. A number of good Canadian brands were on hand, as usually the Lachine canal carries a stock of from twenty to thirty thousand barrels in the sheds, but some of the brands gave more even setting results than others. In the laboratory tests these cements all set



Concrete Testing Closet.

in about the same time, but varied on the work. This was largely due to the fact that the temperature of the water was changing, being warmer towards summer and colder as the autumn approached. The cement was provided by the department, but the contractors demanded a medium quick-setting cement in order that they might remove the face moulds every three days. On one occasion, pending the letting of a new cement contract, some English cement was used. This was a first-class cement, but slower setting than the Canadian, and it was found at the end of three days that the concrete was still soft, and the mould could not be moved for a week. All of the cement used, about seventy thousand barrels, was first tested in the Lachine canal laboratory, in accordance with the standard contract specification, and it was also tested with the sand used and under conditions approaching those of the work. Progressive tests were made with the sand as the various barges were unloaded.

Tests for Time of Setting.—Particular attention was given throughout the cement tests to the time of setting, and on account of the difficulty usually experienced in laboratories in regulating the temperature and the moisture in the air, a new type of concrete moist closet was devised. This closet, now in use for over two years, has worked so well that it will be described here.

The difficulty found in the customary type of moist closet and in briquette tanks is that, on opening up the tank or closet to make tests, the temperature of the air and its degree of moisture is apt to be materially changed. An ideal type of closet would be one where the examination could be made without exposing the test pats to even a draught of air. This was provided by constructing a closet of which the door is used only for placing the pats, and in which an armhole at the side is utilized by the operator to make the test. The cuff of the coat sleeve prevents any air entering from outside, and on the arm being withdrawn the hole is instantly closed.

The closet was 3 feet high, 3 feet wide, and 18 inches deep, with walls of concrete 2 inches thick. The "mix" was made "rich." The bottom, which acts as a tank to hold about 2 inches of water, does not leak, and water is seldom added to it after the first filling, which goes to prove that little or no evaporation takes place inside the closet. The temperature of the closet is usually 65 degrees, both in winter and summer, only varying about 1 degree. On a hot summer day it might run up to 68 degrees. Wet cement bags are placed on top during the very hot weather, and repeated tests show how evenly it can be regulated.

Up to date, about five thousand tests have been made in this closet, and the author recommends it to those anxious to simplify the making of cement setting tests. The Gilmore needles are used, and nearly all of the tests have been made by the same operator.

SETTING TESTS.

| Temperature degrees Fahr. | Initial Set. Hrs. | Mins. | Final Set Hrs. | Mins. | Where Stored. |
|---|---|---|---|---|---|
| 72 | 2 | 47 | 5 | 0 | In water tank |
| | to 2 | 55 | 5 | 35 | |
| 70 | 2 | 57 | 6 | 45 | In water tank |
| | to 3 | 0 | 7 | 12 | |
| 68* | 3 | 7 | 7 | 22 | In concrete closet |
| 66* | 3 | 26 | 7 | 30 | In concrete closet |
| 65* | 3 | 35 | | | In concrete closet |
| | to 3 | 40 | 7 | 40 | |

*Note.—About 200 sets each were made at the various temperatures above 65 degrees. The extreme variations of time, for same brand of cement, was not over 15 per cent. At temperature of 65, in concrete closet, 4,000 tests were made. The pats in each case were moulded as rapidly as possible, all less than a minute. Water used, 22 to 23 per cent. Tests made by same operator, Mr. J. Yorgan, assistant cement tester.

Results of the Work.—An examination of the work, after unwatering the canal on the April following the first season's operations showed satisfactory results, and several points are worth noting. First, that the placing of the concrete had been continued too late in the fall (to October 24th), and as a result of the condition of the water (its low temperature) the concrete of this section, compared with the other concrete, was found to be quite weak. The concrete placed in September had set up hard, and withstood the action of the ice when the water was let out of the canal in April, but the wall placed late in October had grooves cut into it by the ice sliding down, and on this account cost the contractors a considerable sum to refinish the surface.

Second, while some portions of the wall near the water-line had been acted upon by the wash of the waves from passing steamers, and looked rough, it was very hard and firm. The projecting stone from the ballast, particularly those pieces longer than two inches, had secured such a grip in the wall that it was impossible to dislodge them. The lower portion of the face was quite smooth, but the slope made by each section of concrete laid, as the scow was moved ahead, was discernible. It showed that sections of over eight feet before moving the plant were too long.

The top surface, usually flooded for a portion of the time after being finished, showed no signs of scumming, but a portion finished late in October one year, followed by rather severe cold in November, was found, after the snow had melted in the following spring, to have peeled to some extent. The warm sun of April, when the canal was unwatered, had the effect of hardening up any portions of the wall that had been delayed in hard set by the coldness of the water. Laitance, or scumming, of the concrete surface, as described in a paper read before the society last year, has not been found to any extent on this work, either in the locks, basins, or in the general foundation work.

The information thus gained was made use of during the second season of the work. The scow was moved ahead about every eight feet and additional precautions taken to prevent the steamers creating such heavy wave action by making them slow down at a greater distance from the plant. The work was discontinued earlier in October, instead of waiting till the water had become too cold. On examining the second season's operations in the following April, good results were found all along the wall, and the finish at the bottom was remarkably smooth.

The ice had no injurious effect. The stone ballast was exposed in portions of the face, but only slight repairs were required. The action of the ice is one reason for making the concrete

facing on the Lachine canal so thick. About one mile of the concrete facing on the north side was laid with a view to stopping a heavy leakage through the bank. The result was entirely successful.

On the Kaiser Wilhelm canal, where concrete had been placed on the bank in the dry, "it was noticed, even during the construction of the works, that many of the slabs had hardened only at the surface, and that a year afterwards the lower part was still soft and pasty. This was due to the fact that they were laid upon turf and other soil where there was a discharge of organic acids, which had a tendency to unite with the chalk of the cement in such a way as to make soft soap." The conditions of the Lachine canal were not such as to cause this difficulty. There are no peaty banks, although peat and marl abound in the ground back of the north bank.

A peculiar result was noticed at one portion of the wall. A cavity existed under one of the moulds which was missed by the diver. Through this the richer portions of the concrete ran out, and covered about 6 or 8 feet of the bottom of the canal to the thickness of a foot or upwards with a regular mortar. When the section was examined during the following April (1909) this condition was found, and, strange to say, the mortar was almost in a plastic state, although the portions of the wall above, below, and opposite this point were hard. This mortar hardened up as it became exposed to the air during April, but still was unlike the rest of the wall. The inference from the above, and the rusty color of the mortar, was that, having lost the protection of the face boards, the mortar had, before setting, become affected by some of the discharges into the canal from the mills above and its setting retarded. The other portions of the wall had not been affected, as the forms protected them until the concrete had been set. Whatever the organic matter was in these discharges from the mills, it had no injurious effects on the walls, although portions of them near the factories are highly discolored. The illustrations give a good idea of the general appearance of the finished wall, and clearly show the angle of repose of the concrete layers, as the mass settled down, on the side slope.

*The Cost of Operating the Plant.*—An analysis of the cost of the work, to be of value to an engineer, must cover the details of the operating gangs required for each part of the plant, and give the results, the combined units accomplished, in a given time. The cost of materials, sand, stone, coal, oil, etc., will depend more or less on local circumstances, and need not be considered here.

The general experience is that a large plant requires a number of extra men, not usually provided for when the plant is designed. It must also be remembered that the time spent in getting ready and laying up, if the operations go over more than one season, must not be overlooked, as in many cases this is an expensive item, and unusually so with a floating plant in this country.

The gangs employed on this plant were as follows :

*Lifting Scow.*—1 foreman, 4 cranesmen, 1 diver, and 2 assistants.

*Mixing and Depositing Plant.*—1 hoist runner, 1 fireman, 3 trimmers for stone and sand barges, 1 mixer operator, 1 man measuring and feeding materials to car, 1 car operator, 2 men handling cement from barge to scow, 1 man opening cement bags, 1 man feeding cement to car, 1 operator for ram, 1 man operating door of bucket, and 1 man collecting empty cement bags.

*Men Employed on Bank and Scows.*—1 carpenter and 4 helpers for adjusting beam runs and rollers for moving arm of ram, 1 man levelling concrete surface, 1 foreman on barges for sand, stone, and cement, and 10 men on latter.

Supervising Staff.—1 general superintendent, 1 master mechanic, 2 assistant mechanics, 1 carpenter foreman. These were all high-grade men in their class, and were kept employed on the work about eleven hours each day.

The transportation plant consisted of two tugs, eight or nine barges, including covered-in barges or scows for cement storage, and a barge for coal. The cost of this part of the outfit would be probably charged up to the cost of supplies, etc., and need not be considered here. A small repair gang was generally required, and kept on call for repairing the floating plant. This latter item is one that should be carefully considered and allowed for on similar plants. Some contractors, the author has observed, neglect this, but it was not so with the contractors for this work. One good carpenter and three or four helpers should be provided for the maintenance of a plant of this kind, even if new at the start.

The capacity of the plant averaged about 200 cubic yards per day of ten hours. This was sufficient to fill in behind about one length and a third of the forms used—that is, about 130 feet, lineal, of finished wall surface each day. The record is about as follows:

| | |
|---|---|
| 1907, from June 5th to Oct. 24th | 20,000 cubic yards |
| 1908, from May 15th to Oct. 17th | 30,000 cubic yards |
| 1909, from May 12th to June 21st (finish) | 6,000 cubic yards |
| Total | 56,000 cubic yards |

The time from the 1st of May in each year till the date of beginning work was spent in getting the plant in commission. This bears out the remarks previously made regarding the cost of getting ready and laying up floating plants.

On the completion of the work on the Lachine canal the plant was removed to the Soulanges canal, where the contractors had secured a contract for a similar piece of work. The slope of the walls, however, in the latter case, was flatter than those on the Lachine canal, but with some slight changes, the author is informed, highly satisfactory work was done.

Conclusions.—The three seasons' experience in laying concrete under water is sufficient, in the opinion of the author, to show that there is practically no limit to this class of work, provided the space can be confined and heavy currents overcome. As was pointed out by Mr. Vernon Harcourt some years ago (Proceedings Inst. C. E.), "the chief difficulty is found near the low-water mark in cases where there is a fluctuation of the water-level, and just above and below where there is a wash." The "mix" should be, in a majority of cases, what might be termed a "wet putty mix," and experience shows that more washing out will occur if the "mix" has a tendency to be too dry rather than too wet. A few tests will show what percentage of water is best suited to the grade of materials used.

In connection with the use of water in concrete, it may not be out of place here to warn those about to select a mixing plant, that the water tanks usually supplied by the makers are too small, and that the automatic measuring system is generally unreliable. Our experience is that a forty-gallon cask is small enough, and that a sixty-gallon one is much better. A given quantity of water, regulated by the automatic valve, the quantity figured for a theoretical "mix," is of little use on actual work. In many cases the absorption of the dry materials alone will take all the water originally estimated for the entire batch; in fact, the amount of water also changes with the daily variation of temperature and humidity. The man in charge of the water must be trained to use his eyes and some judgment as well as to turn a valve, and the only mechanical perfection required is a tight valve and a quick turn-off.

The author is indebted to Mr. A. T. Gibson, Toronto, member of the Canadian Society of Civil Engineers, the engineer for the contractors, and to Messrs. Haney, Miller, Quinlan & Robertson for permission to use the original drawings of the plant.

The work was carried on under the supervision of the Department of Railways and Canals, through Mr. E. Marceau, the superintending engineer of the Quebec canals, and the author, as engineer in charge of the Lachine canal. Mr. Angus W. Robertson was the direct representative of the contractors on

the site, and, with the author, was enabled to follow out daily the operations of the plant and the results attained.

During the reconstruction of the Lachine canal in the past nine years, which might be appropriately termed its "concrete age" (see Plate E), engineers from all parts of the world have visited the work. Engineers from Austria, Holland and Japan have examined the processes described in this paper, and all have expressed approval of the efficiency of the plant and the excellence of the completed work.

## Report No. 1*

**To the International Railway Congress Association. Eighth Session—Berne 1910.**

**(Austria-Hungary, Bulgaria, Denmark, Germany, Luxemburg, Norway, Rumania, Russia, Servia, Sweden, Switzerland and Turkey)**

By Prof. Dr. Ulbricht, Member of the Board of Works, Councilor of the Royal Saxon Treasury.

### QUESTION X.

**Operation of Switches and Signals.**

A.—Improved centralized installations for operating switches and signals. The use of water, of compressed air, of electricity, for working the transmissions. Electric interlocking. Route levers.

B.—Arrangements adopted to prevent switches taken from the facing or the trailing side from changing their position before the whole train has passed.

C.—Use of diagrams to facilitate the consideration of the full utilization of tracks along passenger platforms and the modifications to be made, in cases of urgency, in the way these tracks are used.

In order to obtain a good general view of the progress which is being made or attempted in connection with the safety appliances considered under Subject X, it was also necessary to incorporate in this report the chief particulars of the older devices principally used, which have proved reliable. * * * [A list of questions was sent out, the answers to which were tabulated and incorporated in the report. From these, the following information was deduced.—Editor.] * * *

HAND-OPERATED APPARATUS.

The experience of half a century, on which the design of the newer hand-operated apparatus is based, has it is true resulted in a desirable comprehenson of some of the questions involved in the design, and have led to more or less uniform practice; but on some important points opinions still differ very much. In the first place there is the question, whether switches at a distance are to be operated by means of rodding or by a double-wire transmission. During the last twenty years wire transmission has become materially extended in the countries this report is dealing with. Germany has adopted double-wire transmission for the operation of switches in the large majority of cases, and Austria-Hungary has adopted it exclusively. Similarly in Denmark, Russia and Sweden, when new installations are in question, double-wire transmission is almost the only system adopted. On the other hand, rod transmission is preferred by the Alsace-Lorraine State Railway, the Baden State Railway, the Rumanian State Railway, the Ssysran-Wjasma Railway and the Swiss railways. The decision of the question, which system of transmission is the best, is not one which is within the scope of this report. It may, however, be pointed out that the chief disadvantage of rod transmission (giving no indication at the station if the continuity of the rodding is interrupted) is only of practical importance in exceedingly rare cases; and that on the other hand, the risk of fracture of the wire, and the defects of the appliances designed to make this harmless have not, in the many applications of this double-wire transmission made, proved so serious that it has been necessary to consider this system of transmission (which is advantageous from many points of view) as unsuitable or even as less suitable.

The new and decided position recently taken by some administrations in favor of rod transmission, has drawn fresh attention to this question; so also has the favorable verdict of the Bruchsal Works, who are very important manufacturers of signaling apparatus. The interest in consequence taken in the subject can be but an advantage from the general point of view. More especially does it have the effect that those in favor of wire transmission are not content with leaving matters as they are, but are observing and testing the reliability of the automatic safety appliances (to act if a wire breaks) under the most varying conditions, and are striving to obtain by stricter supervision and more careful maintenance the results which it is not yet possible to obtain by improved design. In the case of wire-transmission equipments, there are many great technical differences, which show that there is ample scope for the work of designers. In Germany, equipments with stretchers and cuttable switch locks, for the points separately, are most usual; while in Austria-Hungary there are generally no stretchers, but bolts for both points simultaneously with shearable pins at these bolts. In the former country, wire ropes are generally used at the deviation blocks; in the latter, chains are preferred. It cannot be denied that the wire ropes at the deviation blocks form parts more liable to fracture than the wire transmission proper, on the guide blocks. There is a risk of fracture, after a few years of use, even in the case of the best wire ropes. According to the tests made by the Saxon State Railway, a good steel-wire rope having an effective cross-section of 9.6 square millimetres (189,460 circular mils), with the wires laid around a hemp core, can stand about 50,000 to 120,000 forward and backward movements, when forming an S-shaped curve around two deviation blocks and subjected during the test to a tensile force of 150 kilograms (330 lbs.).

It is intended in future to use an effective cross-section of 9 square millimeters (177,600 circular mils) and to specify that the rope must stand 100,000 forward and backward movements.

The signaling system of the Saxon State Railway has experienced, between Jan. 1, 1908, and April 1, 1909, (the weather conditions during the 1908-1909 winter were particularly unfavorable), the following fractures of wire transmission operating switches and signals:

Two thousand eight hundred seventy-five switches with wire transmission: no true wire fractures, but 64 fractures of wire ropes;

Three thousand six hundred eighty-eight signals with wire transmission: 3 fractures of wires and 103 fractures of wire ropes;

Six hundred three switches with rodding, two fractures of rodding and one fracture of a crank.

In the cases of wire and wire-rope fractures which occurred, four signals remained in the position "line clear" and at one switch the lock did not act. That the signals did not automatically fly to danger, was caused in two cases by snow which had accumulated, and one case by the sticking of a soldered part, and in one case by the fact that part of the wooden protective casing interfered with the free movement of the counterweight. That one of the switch locks failed was also caused by the sticking of a soldered part; thus this was a fault in the construction, for if the dimensions of the different parts had been properly proportioned, this could not have occurred. Now although in consequence of the automatically-acting safety appliances, the fractures of wire ropes only result in a dangerous state of affairs in the rarest cases, yet the number of fractures is by no means negligible. It would no doubt be still further reduced if the ropes were renewed in good time, as soon as the signs of wear became apparent. In some districts, very good results have been

*From the Bulletin of the International Railway Congress Association.

obtained in this way. As the above statements show, one great enemy of wire transmissions is snow and ice formation; this not only impedes the movement of the transmission proper, but also that of the signal, switches, etc., and may prevent the appliance which is being operated from assuming its proper end position.

Most of the administrations therefore justly attach much importance to protective casings of the switch gear, and to careful drainage of the ground under the transmitting and operating gear, and no doubt further improvements can still be made in this direction.

In comparing rod and wire transmissions, we also have to consider what necessity there is for any special locking gear on switches operated by the one or the other transmission. We find no great difference in this respect. The managements who prefer rodding in Germany (Alsace-Lorraine and Baden) think it very extensively necessary, in case of rod transmission, to have separate locking gear in addition to the usual point lock. All the switches taken from the facing side, on the Alsace-Lorraine Railway, have such separate locking gear; in Baden, all the switches taken from the facing side by passenger trains, if they are at a greater distance than 300 meters (328 yards) from the cabin and are run over by arriving trains or by trains running through. Rumania, which has also decided in favor of rodding, only uses special locking gear exceptionally, in the case of switches taken from the facing side and situated on curves. On the other hand, Switzerland has special locking gear in the case of switches, operated by rod transmissions, taken from the facing side, on the main line, if they are more than 150 metres (164 yards) from the cabin (this working gear is in connection with the wire transmissions operating the signals), and also in that of switches which are more than 400 metres (437 yards) from the cabin. The switches taken from the facing side and operated by wire transmissions, are protected to about the same extent by the administrations which have adopted wire ropes as their chief means of transmission. In Prussia all the switches taken from the facing side, which are run over by fast trains, are fitted with control bolts. The only exceptions to this rule are, under certain conditions, switches located near the station platforms. In Austria the same protection is adopted in the case of switches taken from the facing side by passenger trains. On the Russian railways, this is done in a limited number of cases only. This tends to show that the practical experience of many years indicates that there is approximately the same safety, whether rodding or wire is used for operating the switches.

If we also take into consideration that those who are exclusively in favor of rodding for the operation of switches employ almost always wire transmissions for operating the signals, and that the importance of the proper position of the signals is just as great as that of the proper position of the switches, we may conclude with certainty that wire-transmission methods will continually be improved, and switch operation by this method will consequently improve, and existing imperfections will be eliminated more and more. It is true that the question of operating signals by means of rod transmission has also been considered; but the greater distances involved in these cases makes the matter rather hopeless. As a substitute, the Bruchsal Works have proposed a combination; rod transmissions for operating switches and electric operation of signals. Such a mixed installation is at present in use in Germany on the State Railway at Colmar.

As most of the more important switches operated by rod transmissions have control bolts fitted, this has made it unnecessary to equip them with an electric control of the switch to show if anything is wrong (failure of the transmission, points not home). In Saxony such an electric control was used for a considerable number of years with success, before switches were equipped with the now-usual cuttable switch lock. This control fell into disuse when the newer point locks were introduced.

The use of cuttable locks with separate movement of the points has become very general, and is very generally recommended. But opinions vary as to whether it is better to do the locking by clamping the blade and the stock rail together, as in the hook locks, or by exerting a thrust against the blade from a special point of support, as in the articulated locks. In Germany as a rule, locks with a clamping action are preferred, although there are also many cases where articulated locks with special points of support are used. Russia, Rumania, Denmark, Sweden and Switzerland, pronounce in favor of the system of exerting a thrust against the blade from a special point of support. Austria-Hungary in this respect takes up a special position, as here as a rule, Siemens switch bolts are used, which make it impossible to cut open the switch without destroying part of the lock; shearable pins are provided for the purpose. When a switch is cut open in this way, there is no reaction at the cabin; but a locking action comes into play at the bolt, and prevents its movement, after the switch has been cut open. The Breitfeld and Danek cuttable switch lock, which reacts on the cabin, is only used to a limited extent. Except in the case of the Aussig-Teplitz Railway, which uses the Schnabel and Henning device, locks acting when a wire breaks are as a rule not used; it is true that the Austrian administrations draw attention to the fact that the fracture of a wire transmission is very rare, and in some cases has never yet happened; this is probably the result of the nearly exclusive use of chains at the deviation sheaves.

In Germany, Rumania and Russia, favorable results have been obtained with devices for holding the switch in its end position if the wire breaks and for locking the operating lever at the same time. One would not like to do without them. Denmark, Sweden and Switzerland have not yet enough experience available to come to a final conclusion on the point.

When the cutting open of a switch breaks the connection between the operating lever and the switch gear, this has given rise to the fear that it would be possible that a switch (when a route has been made) should be, wrongly, disconnected from the operating lever and then operated with the lever provided for making the connection. Practice has shown that this need not be taken into consideration. It is generally thought that the only thing necessary is to place the connection under a lead seal and also to lead-seal the connecting lever. The principle silently observed in the case of many safety appliances here also comes into play, namely, that it is necessary to be protected against the consequences of a mistake, but not to be protected against every possible criminal action of an evil-minded employee.

One special form of wire transmission for switches from which much was expected formerly, was operation with three different positions of lever; in the middle position, the lever releases the switch so that it could be operated locally. This has only been introduced to a very limited extent, except in Sweden. It is only used in a few cases in Baden, on the Moscow-Windau Railway, and on the Swiss Federal Railway, but in Sweden it is used fairly extensively.

Then also the device, from which the wire transmission system of operating switches has developed, the switch bolting, is only applied to a very limited extent, except as regards the control locking of distant switches. Only in Denmark are such locking devices frequently used. In Rumania there are none. In other countries, they are used either as provisional safety appliances or in cases where the traffic conditions are particularly simple. The locking devices are as a rule not cuttable. Only in Russia are shearable pins used for the locking bars; and on the Stockholm-Rimbo Railway the cutting open of a locked switch disconnects the wire transmission of the cabin.

Arrangements for keeping locked switches in their end position if the wire breaks are stated by some to be desirable; but in most cases they are not considered necessary. There are even important reasons against it, for then if when the wire has broken the switch is locked in the end position, the switch can

no longer be operated by hand, after the object of the locking has been attained, and it may be absolutely a necessity, for traffic purposes, to operate the switch. But it is an advantage if the fracture of a wire prevents the operation of the levers in the cabin; and most installations are so arranged.

A matter of importance is the distance up to which switch locking can be considered reliable. For it represents, at the same time, the limit of the distance at which switches can be operated, special switch locking being also used. This largest locking-distance is as a rule 500 to 600 metres (547 to 656 yards), with a wire travel of 500 millimetres (1 ft. 7 11/16 in.). It is true that distances of 800 metres (875 yards) (Swiss Federal Railway) and 1,350 metres (1,475 yards) (Alsace-Lorraine State Railway) are also mentioned, which materially exceed the usual limits of switch operation.

In the case of signaling operations, double-wire transmissions have everywhere replaced single-wire transmissions. The latter are no longer used by any of the railways we are dealing with. The distance up to which, on approximately straight sections, double-wire transmissions are considered safe for the proper operation of signals, is stated to be 1,000 to 1,500 metres (1,094 to 1,640 yards), the travel of the wire then being usually 500 millimetres (1 ft. 7 11/16 in.). Some administrations, however, reduce this, according to distance of signal; on the Austrian State Railway it is reduced to 250 millimetres (9 13/16 in.).

In the case of signals, just as in that of switches, we have also to note an important difference as regards the use of stretchers. In Austria and Hungary, stretchers are hardly used at all. In Denmark also, new constructions are made without stretchers. But in the case of the other administrations, the absence of stretchers is the exception, and is as a rule only found when the distance of operation is less than 200 metres (219 yards). The safety action of the stretcher, setting the signal to "danger" when the transmission breaks, must be replaced in the absence of stretchers by a release which if one side of the double-wire transmission becomes slack allows the counterweight of the signal arm to move it into the "danger" position. The advantages of a uniform initial tension and of the strong pull exercised by the gravity stretchers when a wire breaks, are evident. They are, however, counter-balanced by the disadvantage that the corresponding device has to be inserted in the transmission, and that everything depends on the proper working of this device; not only has it to be protected against the deleterious action of ice and snow, but also against illicit interference; for it makes it possible, when the weight is raised (whether direct from the cabin or by pulling the wire), to change the position of the signal without operating the lever.

Then also the system of ensuring that the signal remains in the "danger" position or is moved into the "danger" position by the weight, in the case the wire breaks, cannot be considered as wholly unobjectionable, if when a wire breaks a signal already standing at "danger" can temporarily assume the "line clear" position before it once more finally resumes the "danger" position.

A question of particular importance is whether it is advisable to use the signal wire transmission also for opening switch locks. That it is not an advantage as regards the operation of the signal, if the wire transmission is a long one, is beyond doubt. Observations have been made showing that the automatic movement of the signal to the "danger" position when a wire breaks can be prevented by such an arrangement; however, generally speaking, no unfavorable results have been obtained with the newer bolting devices, which offer but little resistance. The use of differential locking in the case of intermediate locking has proved very satisfactory, and there are several good designs. Austria-Hungary and Roumania, however, do not intercalate such intermediate locking. In Russia it is used very rarely. In other cases, it is not excluded, but it is in cases observed that it is only used to a limited extent.

The same applies to the combinations of the distant-signal transmission with that of the main signal, which can affect the efficiency of the wire-breaking safety gear, and under certain conditions even the ordinary operation of the signals. Austria-Hungary and Saxony have, therefore, adopted it as a principle to have separate transmissions and levers for the distant signals and the main signals, the levers being, of course, interlocked. The same arrangement exists also to some extent in Russia and Denmark also. But in the other cases distant and main signals are nearly always operated by one lever and by one wire transmission, which is in cases divided at the main signal.

A method of operating main and distant signals, one common wire transmission being used, but developed in quite a different way, has been made possible by the use of electric interlocking in those cases in which the distant signal of a main signal is immediately next to the preceding main signal, or can be erected together with it, for instance when a starting, distant signal is at the entrance signal. It is then not usual to operate both with one wire transmission; but the distant signal is electrically interlocked, so that the circuit can only be closed when the corresponding starting signal is set to "line clear." This method of operation is also adopted when several signal arms are to be operated by one and the same lever. Otherwise the electric signal interlocking (interlocking of arms, arm flying to "danger" position) is naturally the means adopted for making the train act on the signal and make compulsory the operation of the block system and the signals, thus in the case of starting signals of block sections and other similar cases. The electric interlocking of signals, which at first was only applied with hesitation in the case of hand-operated apparatus, now forms a recognized important and reliable addition to it, and is also beginning to be introduced in the cases in which the mechanical control at greater distances is not by itself considered reliable under all conditions.

It is remarkable that ball bearings and roller bearings are as yet but little used on switching gear and more especially on transmissions and distant apparatus, although good results have been obtained with several experimental installations. Only for switch rodding are roller bearings used to any considerable extent. But the fact that in the case of long transmissions it is very desirable that there should be easy operation and action of the automatic safety appliances might form an inducement to pay more attention to ball and roller bearings. It may, therefore, be assumed that such devices will be used more and more.

The size of the apparatus which is hand operated, is as regards the number of levers, within moderate limits. The greatest size is represented by cabins with 70, 80 or 90 levers; and this no doubt is due to the large amount of space required for such apparatus as well as to the difficulty of operating larger installations.

Important improvements in hand-operated apparatus are not in prospect for the moment. However, there is no doubt that further improvements will be made in the combination of electrical and mechanical devices, and it is to be expected that in this way many difficulties, which at present have arisen in the case of purely-mechanical treatment, will be overcome very satisfactorily. Thus the question of safety in the case of the fracture of a wire, is one which is very probably solvable by electrical methods. Then also it may be expected that the development of power-operated installations will stimulate, in more than one direction, the design of hand-operated installations; for at present there is no question of replacing hand operation by power operation in the majority of cases, and attempts will be made to adapt part of the improvements in power operation also in the case of hand-operated installations.

## Power Operation.

Power-operated installations, within the scope of our report, are nearly entirely limited to electrically-operated and pneu-

matically-operated installations. On one railway only, in Russia (Weichsel Railway) are there installations operated by liquid under pressure. The most important ones are electrically-operated installations, the quick development of which is due to the activity of Messrs. Siemens & Halske of Berlin and Vienna, and of Messrs. Judel & Co. of Brunswick; in Germany there are 243 installations, 6,907 switches and 1,824 signals, electrically operated, either in use or being installed; in Austria-Hungary, 22 with 411 switches and 224 signals; in Denmark, 8 with 77 switches and 7 signals; in Russia, 3 with 40 switches and 9 signals. On the Prinz-Heinrich Railway in Luxemburg there are several electrically-operated installations constructed by the Taylor Signal Company of Buffalo (now the General Railway Signal Co.—Editor). Taking it altogether, this is already a very important application of electric operation. Among other power-operated installations, there are in Germany 10 electro-pneumatic installations with 1,135 levers, constructed by the firm of C. Stahmer of Georgsmarienhutte, and then there are also several administrations in Germany and Russia, who have some individual signals operated by compressed carbonic acid, controlled electrically.

The power in the case of electrically-operated installations is nearly always supplied by continuous-current motors, but in Prussia solenoids are also used, in some cases, for signals. In the newer installations, matters are always arranged so that the switch can always be moved, forwards or backwards, whatever its position, and so that after it has been cut open, it can be put again into normal condition without anything special having to be done at the switch itself. The electric control of the proper position of the switch is generally such that it checks the correct position of each of the two blades. In some cases, however, only the whole operation is checked.

The simultaneous operation of several switches is generally limited to the number "two." As a rule these are related switches; when these are acted on by the one common lever, there is, however, this difference that the movement of the two switches is not in all cases effected simultaneously, by switching in the motors in parallel, but that in some cases the two motors are arranged so that the one motor first throws over the one switch, and that when this operation is completed, the current is automatically switched on to the other motor, which then begins to throw over the other switch. Prussia prefers the latter arrangement, for if the first switch fails, the second remains in its original position. In Austria, good results have been obtained with the two motors connected in parallel. On the whole, separate operation of the switches is by far the most general, as this makes the arrangement of the conductors easy, and also eliminates the disadvantage that if in the case of shunting operations several switches are moved simultaneously, the attention of the operators is, as a rule, only fixed on one, and that another at the same time can have been moved prematurely. The time required for throwing over an electrically-operated switch is stated to be two and three seconds, and for a pneumatically-operated one, two to eight seconds; the longer periods in the latter case seem to apply to exceptional cases, in which specially-long transmissions were in question. On the average, the time required for pneumatic operation is probably but little longer than for electric operation. The time required when a fluid under pressure is used is as stated the three seconds.

In order to look after and maintain the power-operated installations, specially-equipped mechanics are nearly always considered necessary; if possible, they receive the necessary practical training when the installation is constructed.

It is true that up to the present, the number of failures has been rather frequent in the case of power-operated installations, although the failures have, as a rule, not been important. In Germany, where there are already a very considerable number of power-operated installations in existence, there are, as a rule, more failures than in the case of hand operation. The same observations have been made in Denmark. In Austria-Hungary and on the Russian State Railway, however, power-operation has, on the whole, shown probably rather more favorable, certainly not less favorable, results than hand-operation.

The installations with liquid under pressure, on the Weichsel Railway, receive a less favorable verdict. Not only have there been more failures than in the case of hand operation, but it has also taken more time to remedy them. On the other hand, in the case of electrical operation, failures have in nearly all cases taken a shorter time to make good than in the case of hand operation. The causes of the failures were varied: contacts not properly closed, the loosening of binding screws, faults in the cables, defective motors, the blowing of fuses in consequence of external resistance to the movement, absence of the check of the position of the blade in consequence of the presence of foreign bodies or movement of the track, defects in the insulated rails, etc. At first sight, this seems rather serious, but it must not be overlooked that a considerable number of these failures result from irregularities in the track and the switches, and that these electric installations in this way form an excellent check on the proper condition of the track, which on the whole cannot be undesirable. The electro-pneumatic installations are perhaps rather less sensitive; Prussia states in this connection, that the only cause of failures was the leaking of the operating piston.

A saving in the staff, in the case of power operation, is not everywhere affected, but, as a rule, there may probably be a saving of 20 to 33 per cent, as Alsace-Lorraine, Wurtemberg, Hungary and the Russian State Railway recognize. Prussia states that it depends on local conditions, whether and what saving in the staff can be effected.

Accordingly, opinions also differ as to what economical advantages there are. These are also affected by the occasionally high cost of maintenance, and by the interest charges of the considerable outlay required; the general experience up to date does not show that these are so marked as to form a strong argument in favor of the future extension of power operation. In Austria-Hungary, however, economic advantages have resulted both as regards staff and as regards maintenance.

The question of the economic advantages is, however, in this case also not the only deciding one; the most important point at places with much traffic is to have such arrangements that the staff can, without being overworked, work the service smoothly, quickly and safely. All the administrations which have up to the present used power installations agree that they make it easier to work the service; this is a sufficiently great advantage to make it certain that power installations will be used in future, in spite of sundry existing minor defects. Therefore, those administrations also, who have already tried power installations in cases of much traffic, consider the further extension of power operation in the case of installations at large stations, particularly, as there is no doubt that progress will be made and such devices will become more and more reliable. Electric operation by motors in such cases receives much more attention than other systems. The administration of the Prussian State Railway, which alone has a considerable number of experimental electro-pneumatic installations in use, states that the comparative trials are not yet completed.

Any suggestions for the improvement of power installations are not made, except as regards some minor constructive details; this is very natural, for the administrations are at present engaged in testing and adapting the existing appliances, which are the result of the excellent and ingenious work of inventors. It must, however, be mentioned that a certain difficulty arises from the fact that the electrical installations require continuous current, while single or polyphase currents are available at so many places. The desire expressed by Saxony, that it should also be possible to use alternating-current motors, therefore does not seem unjustified.

(To Be Continued.)

H. Rindal, assistant engineer of the Canadian Pacific at Winnipeg, Man., has been appointed engineer of the Pacific division, with office at Vancouver, B. C., succeeding C. E. Cartwright, resigned.

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The Chicago & Northwestern will hereafter use upper right-hand quadrant semaphore signals exclusively for new work and renewals for both block and interlocking signals. The interlocking plants now being constructed at Kinnickinnick Bridge, at Mayfair, and at Canal Jct., will be equipped with this type of signal.

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## The Section Forces in Railroading *

By L. G. Morphy.

It is probable that outside of the members of the transportation, engineering and maintenance of way departments, comparatively few men—even among other railroad employes—have an opportunity to realize and fully appreciate the important part that section forces play in the operation of the railroads and the comfort of the traveling public. Out of the 890,009,574 passengers carried by the railroads of the United States during the year ending June 30, 1908, it is safe to say that a very small percentage gave more than a passing thought to the numerous gangs they saw, or did not see, along the right-of-way as the train on which they rode sped along, or possibly whom they noticed leaning on a bar, shovel or other track implement while a train stopped at a station where the section gang was waiting for the train to depart in order to proceed with work on the very track on which the train stood. And yet, out of the 1,458,233 persons reported on the pay rolls of the railroads of the United States for the same year, there were 442,936, or 30.3 per cent., occupied exclusively in the maintenance of track and structures, and these 142,936 employes maintained the track and structures over which were carried not only the 890,009,574 passengers, but also 1,532,981,790 tons of freight, besides the innumerable side tracks, yards and other structures comprised in the 235,300 miles of main line of railroad in operation in the United States during that period. Furthermore, out of a total of $1,687,144,975.74 used for operating expenses on these railroads, the cost of maintenance of way and structures was $324,756,690.57, or 19.25 per cent., which is at the rate of $1,423.35 per mile of line operated.

Before passing to a general description of the work done by the section forces to illustrate how they are related to the operation of the railroads and to the comfort of the passengers, it may be of interest to note the following statistics all referred to the same period, viz.: the year ending June 30, 1908:

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| Number of passengers carried one mile | 29,082,836,944 |
| Number of tons of freight carried one mile | 218,381,554,862 |
| Gross revenue | $2,421,542,004.76 |
| Total operating expenses | $1,687,144,975.74 |
| Total maintenance of way and structures expenses | $324,756,690.57 |
| Ratio of operating expenses to total operating revenues | 60.67 per cent |
| Ratio of maintenance of way and structures expenses to gross revenues | 13.41 per cent |
| Ratio of maintenance of way and structures expenses to total operating expenses | 19.25 per cent |
| Total operating revenue per mile of line averaged | $10,613.13 |
| Total operating expenses per mile of line averaged | $7,394.42 |
| Total maintenance of way and structures expenses per mile of line averaged | $1,423.35 |

It is customary to split the territory covered by a railroad into districts or divisions, and place the maintenance of each in the hands of an engineer, variously called assistant engineer, engineer of maintenance of way, or division engineer, each division being further divided into sub-divisions in charge of a roadmaster or supervisor of track, reporting to the division engineer. Each sub-division is in turn divided into sections in charge of section foremen to each of whom is assigned a force of men varying in number according to the location and length of the section, the density of traffic, the season of the year, and other local conditions. An excellent way to apportion the section is by endeavoring to equalize the amount of work on what is known as an "equivalent mileage" basis. There are several methods in vogue, but all consist of giving the work of maintaining side tracks, turnouts, slip switches, etc., a rational proportionate value to the amount of work required to maintain one mile of main track. The New York Central has, for a number of years, used the following equivalents:

Two miles of side track equals one mile of main track.

Fifteen turnouts equals one mile of main track.

One crossing frog equals one turnout.

One single slip switch equals three turnouts.

One double slip switch equals four turnouts.

With these or other values in mind, and a knowledge of the local and traffic conditions governing, it is a comparatively simple matter to apportion a given territory so that the equivalent mileage on main lines with heavy traffic will be from eight to ten miles; on branch lines from ten to fourteen miles; and on yards from fourteen to twenty miles. Generally speaking, the average section will consist of a foreman and five men in winter, and a foreman and ten men in summer, or roughly speaking, 0.3 to 0.5 of a man per equivalent mile in winter; and 0.8 of a man to one man per equivalent mile in summer; these figures, of course, do not include extra forces used for renewals or other special work.

The section foreman, within his territory, is the guardian of the physical property absolutely at all times, and must consequently not only be ever vigilant, but also thoroughly competent and reliable. He must always be within call of the superintendent or dispatcher, as well as the supervisor and division engineer, and when trouble occurs must at once get his forces together, protect the company's property and do all in his power to help. During storms of any kind, high winds, freshets, ice jams, fires, or other events threatening the safety of the road in any manner, he is always to be found patrolling the tracks and prepared to act in an emergency, cheerfully staying on duty—no matter how long this may require or what hardships he may endure. He is required to warn trespassers off the right-of-way; must keep road crossings and station grounds clean and in good condition; remove obstructions to view, wherever possible; watch the telegraph line for breaks and repair them if he can; prevent encroachments; be familiar with the laws and regulations affecting his work; protect his men from accident; be conversant with the time-table and the use of signals; have one of his men carrying such tools as are likely to be required; carefully examine at least once each day the track, roadbed, frogs, switches, switch-stands, rail joints, rails, road crossings, bridges, bridge-warnings, trestles, culverts, ditches, cattle-guards, fences, farm gates, signs, and telegraph line within the territory covered by the section, to see that everything affecting traffic is safe; he must see that labor and material are economically used, and he must first, last and all the time, maintain the tracks in good condition.

It is, therefore, plainly to be seen that a section foreman must be reliable, honest, temperate, competent and intelligent, for although the supervisor of track and division engineer frequently go over their respective territories, the section foreman is the man on the spot and on him rests the prime responsibility for the proper and economical maintenance of his section.

Now in regard to the maintenance of track:

The track, above the foundations or roadbed, consists of four essential parts, viz.:

1st. Ballast. Consisting of a layer of earth, cinders, sand, gravel, burnt clay, furnace slag or broken stone, forming a cushion in which to imbed and hold the ties.

2nd. Ties. These are of variable dimensions and quality, depending on the available source and requirements.

3d. Rail. Properly jointed and bolted.

4th. Spikes. To hold the rails on the ties at the proper distance or gauge, and to prevent overturning.

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*Read before the New England Railway Club.

The ideal foundation or roadbed is one of solid material, perfectly drained, but in its absence irregular soft spots must be found and the track will settle at these. When the track is thus unevenly settled it is said to be "out of surface." This condition results in a jar to passing trains, and if not soon remedied may cause a permanent set or bend in the rail which is difficult to remove. Bad surface must be avoided at all places, and very particularly on curves. A good section foreman invariably follows up his track for good surface with the utmost care. In the summer, when tamping is sufficient, this is not so difficult, but in the winter, when the roadbed and ballast are frozen and good surface must be maintained by pulling the spikes, lifting the rail from the tie, inserting shims of the proper size and respiking it, sometimes it requires considerable skill and always considerable time. It may be said, in fact, that keeping the track in proper surface takes more time than any other single item of maintenance, particularly during the winter months and in the early spring when the shims must be changed and gradually removed, as the ground thaws and allows the track to settle to its normal condition.

Cleaning the ditches to facilitate drainage and minimize surface troubles, is another item of maintenance to which the section forces must give a good deal of time and attention in the early spring, and in the fall of each year. The work of removing shims and going over the tracks for surface, super-elevation on curves, gauge and general line, done, the section force is now ready to undertake the tie renewals.

The method of procedure is dependent on the kind of ballast. In dirt ballast or where a sag is to be raised, the simplest way is to pull the spikes from the ties to be removed, raise the track about an inch and pull the ties out with the pick—without digging. The new ties are then put in, spiked, and the track surfaced, taking care to respace the ties where needed. In other kinds of ballast the usual method of removing ties is to dig a trench beside the tie to be removed, slightly deeper than its thickness, pull out the spikes, drive or pull the tie sidewise into the trench, and haul it out with the pick; then prepare the ballast where the new tie is to be placed and put it in, properly spaced. If the space on one side of the old tie is wider than on the other, the trench should be dug in the wider space to avoid extra digging in re-spacing. All spikes are pulled with a view to using them again, and the spikes on adjacent ties are started so that if necessary the rail may be raised to remove the old ties without disturbing the bed of the remaining ties. In dressing the bed for the new tie, the old tie-bed is widened and the bottom cut down very slightly in case the new tie is thicker, but the new tie must fit snugly so as not to have it lay on a new bed of loose ballast. An adz is always kept available to remove imperfections from the new ties, and to prepare an even and smooth bearing for the rail before spiking. Special attention is given joint ties, and trains are not allowed to pass with a tie out, particularly at a joint. Where tie plates are used, these are removed from the old ties and used in the new—if the conditions warrant—and in all cases the track gauge is used in spiking. The old ties are then assorted, such as are fit for further use being neatly piled awaiting disposal, and the others placed in a pile at a safe point and burned. It is customary to allow each section man a given number of old ties for kindling.

A word here is pertinent as to the manner of determining just what ties need to be removed. As the appearance of ties in the track is likely to be deceptive on account of the various ways in which they rot, they are subjected to the pick test on curves. This consists of striking the tie a moderate blow with a pick on the outside of the outer rail. Should the tie split or be found badly decayed, it is taken out. Ties on curves are also carefully examined for their spike-holding qualities. On tangents the end of a bar is inserted under the tie and pried up as if to raise the tie. If the tie is found sufficiently springy it is taken out. It may be generally said that ties on tangents outlast those of the same quality on curves by at least one year. In all cases, renewing a number of ties together, or out of face, is avoided, as this necessitates disturbing the ballast for a considerable distance and results in bad surface. Considerable judgment must be exercised in the selection of ties to be renewed, and the supervisor always gives this matter his attention in the fall of the year, basing his requirements for the ties to be used the following season, on personal observation. Ties are notched or otherwise plainly marked to show when they are placed in the track, in order to permit a check on their length of service. The average number of ties used for renewals should not exceed two per rail length per year.

It is a mistake to prolong the work of tie renewals through the summer. The surface and line of the track are at their worst just after the frost leaves the ground, and the work of renewing ties is always a source of more or less additional disturbance, so that it results in economy to renew the ties as quickly as possible and then go over the entire section once more, thoroughly tamping all the ties to a good surface. Generally speaking, all new ties are in place by not later than the first of July.

If ballast is to be renewed, all the dirt is removed from between the ties as far down as their bed, before the new ballast is unloaded. The old ballast removed is used to strengthen the shoulders of the roadbed in fills, and is removed in any case to avoid its mixing with the new ballast. In no case should low places be left in the old ballast bed, as these will catch water and create soft spots.

The work of re-ballasting main tracks carrying heavy traffic is done by an extra gang, the section forces assisting. If the lift is such that more than one tamping will be required, it is well to raise the rail to grade stakes given by the engineer, shovel-tamp the ties under the rails for a distance of about one foot each side of the rail, but not at the center; fill the spaces between the ties inside the rails full and loosely, permitting the material to find its way under the center of the ties as trains go over the track. After a few days the gang goes over the entire stretch once more, properly tamping the ties, putting the track in good line and surface, and filling in where necessary. During the process of re-ballasting a run-off or gradual drop is made each time a train is to pass over the track, and slow orders are made effective when necessary.

When rail is to be renewed or re-laid, the section forces adz the ties to prepare an even and smooth bearing for the new rail. This work is also usually done by an extra gang assisted by the section forces. After the rail has been distributed, turned and placed on each side of the track, there are two general methods of procedure: first, to change one rail at a time, and second, to connect a string of say twenty rail lengths and throw it in as a string when the old rail is taken out. The first method is more expensive and slower, but at places where traffic is very dense it is practically necessary. Rail renewals cause a very large amount of work and expense, principally at points where there are turnouts, crossings, etc., which must of necessity be renewed simultaneously with the rail.

While the above constitutes the fundamental work of the section forces in maintaining track, there are innumerable details to be looked after by them, such as keeping switches, frogs, guard rails, anti-creepers, derails, bumping blocks, and other track appurtenances in shape, cutting grass and weeds, repairing fences, unloading coal, assisting other departments in the handling of material, etc. By the time the regular work is done the fall season is close at hand, and the section forces take advantage of the dry weather before the ground freezes or the winter rains set in, to clean out the ditches, giving particular attention to those in long cuts where water might collect and form ice, cleaning the water-ways leading to culverts and bridges, to avoid, as much as possible, damage due to freshets or ice jams, scouring and wash.

For the sake of system and uniformity, the section forces are required to commence the season's work at one end of their section and work continuously to the other end, alternating each year, and two section forces commencing at the common point. By following this practice the fewest number of working places are secured .

And then the winter sets in with its usual storms. The regular section forces have now been reduced, the foreman must always be prepared to get sufficient men to keep the snow away from switch points and interlocking devices; from flange-ways, station platforms, driveways and public ways within the right-of-way, to fight ice jams, guard such spots as may appear dangerous, and otherwise protect the best interests and safety of the railroad. In cases of prolonged storms it is not unusual for day and night shifts to be required for extended periods, and arrangements must be made to feed the men so that the section forces still are and always will continue to be busy, and considerable responsibility rests with them.

## DISCUSSION.

The President.—Gentlemen, this is certainly a very interesting paper, and to me it is a very instructive one. It points out to me the fact that no matter how well the mechanical and car department do their work, no matter how carefully the operating department takes care of its end of the business, without thorough organization, system and eternal vigilance on the part of the track forces, the railroads are still very apt to have serious trouble. I believe there can be a whole lot said on this subject, particularly by the maintenance of way men, and I hope that they will avail themselves of the opportunity to promptly discuss the paper.

Mr. H. E. Astley.—Mr. President, Mr. Morphy has brought out some very interesting points relative to the section forces and their work. With the present heavy equipment now going over the rails, and frequently with rails not of the heaviest pattern, it stands to reason they have a great deal to attend to, properly to maintain their track and keep it in good condition. The roadway department forces of course may not rank as high to many, as some other departments, at least they would not if some other employes were asked about them, although in my opinion they have as important a duty to perform as any other department. The section foremen as a rule are an intelligent and reliable class of men, well versed in their particular vocation, and realize their responsibilities, and if some of them heard the figures that were read here to-night I think they would agree with me. It might be interesting to know that if we take into consideration the ties, which must be kept renewed and in proper position; the rails, which must be kept to proper surface and renewed when necessary; the spikes, bolts, angle bars and fastenings which must be properly maintained, all counted up would equal about 16,000 parts in one mile of single track, which are to be cared for and looked after by the section forces. I agree with Mr. Morphy that a small percentage of the traveling public notice the section forces, or even their work to any extent. However, they do notice more the work of the motive power and operating departments. When the average passenger reaches a station he will take note of the regularity of trains, the condition of cars, the neatness of the station, and is quick to note any slight deficiencies and to make suggestions and demand all manner of improvements, and the public generally gets what it wants. They take, as I said, but little notice of the track or the roadbed—the foundation of the house—unless extremely rough, but motive power men will find that their expenditures depend more largely on the condition of track than is generally realized.

The matter of drainage of roadbed has been explained, and that is one point I cannot help mentioning, as it is a vital part of railroad construction. Without adequate drainage it is impossible to maintain a good roadbed.

The question of ties is one upon which much can be said, as the cost of tie renewals has become one of the largest factors among the charges for maintenance of way. The renewal of two ties per rail length per year I think is rather small in this part of the country if we use our native ties. At present, railroads are giving more attention to the matter of preservation of ties to lengthen their life. The road I am connected with has gone into that considerably. I find, using a treated tie with shoulder tie plates and a screw spike, the results being very satisfactory. It is thought that the life of a tie is at least doubled. It is said that there are over 10,000,000 ties used in the United States annually, and about 16 to 20 per cent. only are subject to treatment by creosoting or other processes, although by the treatment of ties it is said that a tie which would ordinarily last six or seven years, after treatment will last from twelve to fifteen years, and the cost of treatment from figures I have is in the neighborhood of 35 cents per tie, which would show that preservative treatment is an economical manner of handling them.

Mr. Geo. E. Sampson.—Mr. President and Gentlemen: I think the thanks of your society are due to the author of the admirable paper which has been read this evening, for it has no doubt taken him many hours of careful research and much reading of dry statistics to condense and get into shape the facts and figures which he has stated. It is, perhaps, an old story to assemble such facts, for the routine of the railway department work has been very similar for years back, varying only to a slight degree of detail; but to have these figures assembled gives us an idea of the volume of business up to date, and I notice that he quoted figures for the year ending June 30, 1908, which I presume is as recent as such figures have been compiled by the public authorities or by "Poor's Manual" or otherwise. At all events, it certainly took a great deal of time to study over the facts and get these figures into such condensed form as to be up to date and serviceable for ready reference.

The figures stated for the ratio of operating expenses to earnings, being 69 per cent. and a fraction, are about the same as the 70 per cent. which most of us no doubt have carried in mind as a proper basis for comparison between different railroads. Although some of the western railroads have their proportion of expense considerably less than that, there are other roads which run higher, of course, to produce this average. I can't speak in any critical way of what has been said, but when we consider—take the question of ties, for instance—the statement that two ties per rail length are renewed every year, and think that on many miles of track the average might be 16 ties per 30-foot rail, it would mean that all the ties are renewed once in eight years on that basis; and if we have 18 ties per 30-foot rail, it would mean once in every nine years. But as a matter of fact on the trunk lines and lines of heavy traffic the ties are renewed more often than that. It calls to mind how necessary it is to preserve our resources and not have the forests die out.

The routine of the section man's work, as mentioned by the author, is interesting, and if I might call attention to it on lines a little bit different, I might say that his duties are about of the nature and order of routine, as follows: He is always on the watch to put out and prevent fires, and especially so in the spring of the year immediately after the snow disappears and before the green spring vegetation appears. Starting perhaps in the month of April, early April, last of March, when the frost comes out of the ground and the forces are increased from a winter to a summer basis, the first duty of the section man is to renew the ties, and it certainly is a laborious undertaking, as any one of you will readily realize after watching a gang busily at work, to do the work in a systematic manner, to have the rails in order for the movement of every train which is scheduled to pass over them, so that none of these ties, especially none of the joint ties, are lacking when a train is due. The foreman has in mind the movements of the scheduled trains with almost the precision and regularity that the

watch hands move on its face, and he has to gauge the movements of his laborers so as to keep the track in order to offer no obstruction and to avoid the necessity of flagging. But when you consider that those section men are working from early April to some time in the summer, perhaps midsummer, in digging in ties and doing that work day after day, it means men of muscle and of grit, and it means a man who is trustworthy and faithful to his work, determined to do it right because it is right to do so.

I know of nothing which is a better evidence of the dignity and worth of manual labor than the faithfulness of these men, who work early and late. They are not scholars, they are not men of learning, many of them are unable to read and write, but still they attend to their work faithfully and are loyal to the corporation for which they work. I have in mind now men in the service of our railroad who have worked since 1873 continuously in the service as section hands, and who have always been faithful to their duty. It means a good deal to live in that temperate and proper way which enables a man to be faithful for so many years and to fill the position assigned to him, even though it is a lowly one in the scale as far as standing in the community is concerned. The occasional fault or weakness of an individual employe should not be considered as a sample of the quality of section men taken as a whole. Times are getting now so that a better education is required than in former years, and it became my painful duty a short time ago to retire a man who had been forty years as a section foreman because he could not read and write. It so happened that he was not dependent, he had property enough to keep him in his old age, but I mention this matter to show that some qualifications are required now-a-days that were not considered necessary in former times.

If we follow the next order of duty of the section man, after the placing of ties and the shovel tamping, it is to start over the section and bar-tamp each of those ties, to put the track in a good condition as to line and surface, true up the alignment of curves, take out the little kinks and have the surface perfect, and that may be said to be accomplished in August. It is next in order to mow the right of way, to clean up the roadbed, dig out the weeds which have started within the ballast section, and when I say the ballast section, we may say that it is the duty to keep clean a specific width between the shoulders on either side of the track, or between the side ditches, and such cleaning up is accomplished at the time of tamping of track to put it in perfect surface and to keep the roadbed uniformly hard, if it may be possible. After this tamping and surfacing work the mowing of the right of way and the brush within the fence lines comes along, and the burning of the hay, the weeds and bushes, to keep everything orderly, neat and tidy. After such cleaning up of the right of way is accomplished, then comes perhaps the easiest time of all the year, in the fall months, and then comes also the time when this force must be reduced from the summer basis to a basis perhaps half way between summer and winter; but at that time, when the fall rains come along, the poor spots in the ballast are detected, the rains soften it up and the track goes out of surface where the section man has spent so much labor in attempting to perfect it during the summer. So that there is no lazy time, no loafing time, it is a continual round of steady and continuous employment, and time is again to be spent in going over the section to tamp up poor spots and to put the track into good surface before the frost strikes in and forms a crust which holds up through the winter.

Now the frost enters the ground, and while it does not begin to heave unevenly until it gets pretty deep, still if the season is severe in the latter part of December the section man comes along some morning and finds an inch or a half inch or more where he has got to put in shim blocks to put it into condition, and he must watch for those places carefully all the time through the winter to keep it in order. In addition to that he must be on hand during snow storms. And when you talk of that it means work through the day, through the night, continuously, taking only such time as human nature requires for food and sleep, because at interlocking points, at slip switches, at all turnouts, where we have point switches, the small accumulation of snow between the stock rail and the point rail must be kept out. Brooms, shovels, all devices, must be used to keep the track clean.

Speaking of that, I want to call attention to the difference of present day rail patterns from what they were years ago. I well remember in the Centennial year, when I first began railroading, in 1876, a 3½ and a 4-inch rail. A 3½-inch rail was common, and a 4-inch 60-pound rail was considered perfection, the best thing in the market. In those days section men on the up-grades had to start to shovel the flange way, in other words, shovel snow off the running side of the entire length of each rail of the main line. In these days of a 6-inch 100-pound pattern we have comparatively few storms—I won't say few, but many of the storms which formerly caused trouble do not cause trouble because of the 6-inch pattern being above the top of the snow, so that the men are relieved from this digging of flange ways; it is not a common thing now-a-days, and banging cars can accomplish what was formerly demanded from the section men.

You can readily see, with the routine that I have laid out, with the character of the track in winter, the need of being on hand every time a notice is sent out that a snow storm threatens, how faithful the man must be, how he has got to be on hand when a heavy rain storm or flood or other accident or liability of accident threatens. These men are on hand. That is the rule of the road. They must be ready on call. Their places of residence are noted at headquarters; they are all known. They willingly hold themselves ready for service, and whether it is at night or day, whether it is a wreck, a storm or accident, they are to be depended upon, and I think the percentage of accidents caused by defective roadbed has been reduced to very small proportions.

Mr. A. J. Desoe.—Mr. President, I think this is the first time I have heard this subject discussed before the club, possibly it may have been while I have been absent, but it really is one of the most important subjects pertaining to railroading; in fact, we, in clubs and associations of this kind, do not pay enough attention to the matter of maintenance of way. When I read the advance copy, it struck me that it needed very little discussion, but since hearing it read and the previous speakers' remarks on the subject, I find that the matter is of very great importance and the paper has certainly done credit to the subject.

I believe the enginemen and the section foremen should keep in close touch with each other. That the engineman should talk over with the foreman whenever he finds any unusual bad spots in the roadbed, whether it is fancied or real, and that the foreman should ride over his section on the engine now and then. I know that that used to be the practice in former years more than it is now.

One of the speakers mentioned the passenger noticing the condition of the engine and cars, the stations and the approaches thereto, etc., but paid very little attention to the condition of the track and roadbed, but I want to say that if the track rode hard, that the blame for poor conditions would be laid at the door of the motive power and car department, therefore if the subject of roadbeds were better understood by the public some of the criticism now put on the motive power department would go to the maintenance of way.

It has occurred to me when reading about the conservation of forests that sooner or later it will be necessary for the railroad to use some other material for ties, but as one of the speakers has said that there is a preservative now being successfully used, we may not have to worry about this matter for some years yet.

Some of us who are connected with the motive power department think that the maintenance of way department sometimes is too strict regarding the wear of ties, but those who run the engines believe they cannot be too careful in this respect.

I wish to pay my tribute of praise to the present force in this department, for on the road where I am employed, at least, they are keeping up with other branches of railroading in making improvements over old methods and meeting conditions as they arise, and our roadbeds were never kept in better condition than they are to-day.

Mr. J. P. Snow.—Mr. President, I have a good deal of sympathy with what the last speaker has said in reference to this club not giving quite so much attention to maintenance of way matters, perhaps, as to equipment and other features of railroading, and as this evening is devoted to maintenance, I presume it is up to the parties interested in maintenance of way and engineering to keep the ball rolling. I don't know much about track work, but I will say a few words in regard to drainage.

This question of drainage of track was spoken of by two of the speakers here as being important, but they did not say much of a practical nature about it. I remember twenty odd years ago, when I used to go with the section crews quite a little on their hand cars to examine structures, that we would frequently go to a place where there was a wet cut, and the foreman in charge would tell a doleful story about his troubles with it, and in his opinion he had the worst section on the system to take care of. Ten or twenty miles away we would come to another bad cut, and that fellow, in his opinion, had the worst section on the system; and so it went at all wet places, and of course they all had their different methods of treatment; but they were pretty uniform in the statement that deep ditches were what they wanted if they could only get men enough to dig them, or get the steam shovel to widen the cuts out, so that they could make a deep ditch. Once in a while one of them by working overtime or some other way would get a ditch down pretty deep, and then the trouble was increased. Every time we had a cold snap the frost would go in under the ties from the side of that ditch, and the question was what to do. One of our roadmasters I think has solved the question completely by putting in farm tile in place of deep ditches, digging a trench, putting in tile, perhaps a four-inch farm tile, and bedding it in cinders, surrounding it with cinders, so that the infiltration of water into the tile would not bring in a mess of silt and clog it up, and then filling his ditches up almost level with the bottom of the tie, leaving a little depression to take off the surface rain water, but not depending on the ditch for drainage at all. In that way his shoulders were protected from frost, and the water was taken care of way under ground by the tile. I think that is the proper solution for a good many of the troubles of these men who have "the worst section on the road."

The value of cinders is great in railroad maintenance. They have a peculiar quality. You cannot make clay go through cinders. Take a sidewalk, for instance, that is clayey and muddy and bad, and spread fine broken stone over it, as they frequently do, from a crusher, and the next spring the mud will be on top and the stone will be out of sight. But if you put cinders on the clay, the clay won't come up through the cinders as it does through the stone. That is due to the porous nature of the cinders, which takes the moisture out of the clay, and then the clay itself, after the water is out of it, is a good shield to prevent other clay from coming up into it. The gravel or crushed stone does not have that absorptive quality, and the clay churns right up through it. This quality of cinders is very valuable in the treatment of bad clayey cuts on a road where the clay runs on banks, for instance. If you can cover it with six inches of cinders it will stop all of the clay running, because the surface water will come up into the cinders and run down through them, and the clay is drained enough to solidify it. As for cinders for use as ballast, they are not a great success, I believe, where the traffic is heavy, but where the traffic is light cinder ballast makes a very good roadbed. I want to say a good word for cinders.

Mr. Chas. H. Bigelow.—Mr. President, I think the speaker who stated that passengers do not notice the results of the work of the department of maintenance of way was a little mistaken, because I think a person that rides very much on the road will notice the difference; whether he is riding over a well surfaced track or whether he rides over a track that is out of surface, is rough and rides hard. Another thing, while in this part of the country, there are many good materials that can be used for ballast, yet in the southwest it is a different proposition and it is more difficult to get good ballast. One material that I have seen used a good deal in Texas is a burnt clay that the railroads make themselves. They will take a large field of clay, pile up old ties, start them burning and then cover them over with clay by means of a steam shovel, continuing this until the entire field is covered with the wood burning under a layer of clay. This will smoulder until the clay is burnt into a kind of brick which is then loaded onto flats and taken where needed and used for ballast. This makes a very smooth-riding roadbed, one that wears well and I am informed not very expensive.

Prof. C. Frank Allen.—One point has already been mentioned, that unless the work of the section man is well performed, the effects will be felt by the rolling stock people or the operating people, and it of course is true that if the track is not in good condition, the wear and tear of rolling stock will be one way in which it really is felt, although it may not be recognized that the bad results do come from poor track. But there is another way, dear to the heart of the operating man, in which the effect may be felt, and that is with bad track you don't get your tonnage behind the engine; the resistance is greater, and you haul fewer cars. You must not in any way fail to recognize the fact that that is one of the results that comes from poor track.

Not very much has been said, except by the last one or two speakers, on the matter of ballast; but I think it is generally recognized that the best is broken stone ballast, of which we have very little in New England. The chief engineer of a road in the south, a very low grade road, which carries tremendous loads of coal with very heavy motive power, told me that for their heavy service broken stone was absolutely essential. I have been for many years attending the meetings of the Railroad Club, and one of the things that impressed me as strongly, perhaps, as anything I have heard here, was a statement made perhaps two years ago, at the last meeting at which this general subject was discussed; one of the locomotive enginemen rose and said that in riding on his engine, on a fast run out of Boston, in winter or early spring, he felt pretty happy when he came to a stretch of broken stone ballast, because then he felt as if he had something underneath him; it seemed to me that that was one of the strongest arguments I had ever heard in favor of broken stone ballast; it meant something coming in that way.

In prolonging the life of ties by preservation, there are several gains. One is, of course, that some direct economy is secured by treating a tie for less than its cost and thereby doubling its life; but there is another economy that is not to be neglected altogether, and that is that the less frequent renewal of ties makes the disturbance of track less frequent, and so keeps the track in better shape, and you have the resulting condition of better track both for the benefit of the rolling stock and of the train load.

One of the speakers has mentioned the faithful work that the section man does. As it happened, I had something of a conversation, I think to-day, with Professor Breed substantially on this same subject, and although it is my business to educate young men to occupy positions where they may be

able, many of them, to show some brilliant work, work that will secure the commendation of people that they deal with, yet I confess that I have a feeling of the utmost respect for the man, in whatever walk of life it may be, who is trudging away doing his duty in a simple and effective way, where he knows that no special recognition will ever come to him, and yet with faithfulness, care and devotion attends to that work. In some sense that man is a greater hero than the man who does valiant deeds, and as I say, it was only today, I think, that we were talking of the subject in this particular way. It is not the first time that I have expressed this point of view in one place or another, but I think I have never had opportunity to express it here. The world has great need to-day, it always has great need, it always will have great need, of the man who can really fill a small place, and I think, perhaps, the section foreman or the section men constitute as good an example as you can find of the man who is capable of filling a small place.

Mr. John Ewart.—Mr. President, while I am not a section man at present, I have known a little something about it, and I wondered where the purchasing agent came in on this business. I don't know how the roads are now, but years ago while the section foreman figured that he wanted about 1,000 or 1,500 ties to put in for renewals, and wanted to begin as soon as the frost was out of the ground, starting in with about 250 ties on hand when he ought to have had 1,500. The purchasing department did not get the ties, and they came stringing along until August; and the section foreman would not get his ties in until the latter part of August and September, when that business all ought to have been done in May or June. I have had section men tell me it took the heart out of them to be obliged to put in ties in September, or even later, when they ought to have been giving the track the final surface, getting ready for winter. The result was that they went into winter with the track half tamped and half surfaced and had to fight it all through the winter, where if they had got the ties in season they would have been in good condition for cold weather. I don't know that they have that experience now-a-days, because the railroads have more money, but in those days they were poor and they did not like to let the money lie by that they had to put into 40,000 ties to carry them through the season, so they would buy for spring delivery and the poor section foreman had to take the blame for a poor track when he was not really to blame.

Prof. C. B. Breed.—Mr. President, I have been thinking along the line suggested by Mr. Astley, namely, the effect upon track of the rapid increase of weights of rolling stock; and the result this has had, and will exert in the future, upon the work of the section foreman. Without a doubt he has been put to it very seriously during recent years to keep his track up to the requirements of heavy traffic and of high speeds combined with the ever increasing wheel load.

These developments have presented to the maintenance of way department very serious problems, and unless we have reached practically to the limit of growth in wheel loads and speed, the question apparently is slowly forcing itself to the front as to whether the present system of cross-tie supports for rails will not have to give way to some longitudinal support. The rapid increase in cost of ties, the advanced development in the use of reinforced concrete, together with the demand for a type of construction which will successfully support the rails and still have the proper flexibility may perhaps bring forth a concrete longitudinal support with some material, such as wood, to act as a filler between the base of the rail and the concrete longitudinal. Such a type of construction probably would decrease train resistance, which means a lowering of the cost per ton mile; and at the same time it would revolutionize to some extent the work of the section foreman and probably require fully as efficient labor as the present type of track construction.

(To Be Continued.)

# Reinforced Concrete Columns

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The exact function performed by steel reinforcements in concrete columns, whether in the form of longitudinals or as hoops or spirals, has been the subject of much speculation and investigation. The behavior of the composite material under stress has not been and is not now satisfactorily understood. Do the steel and the concrete deform together in accordance with the classical assumption to that effect? Are there initial stresses in the metal (and also there in the concrete) due to a tendency to contract while setting? Does the presence of the steel affect significantly or at all the elastic properties of the concrete which immediately surrounds it? Is the use of reinforcing metal, either as

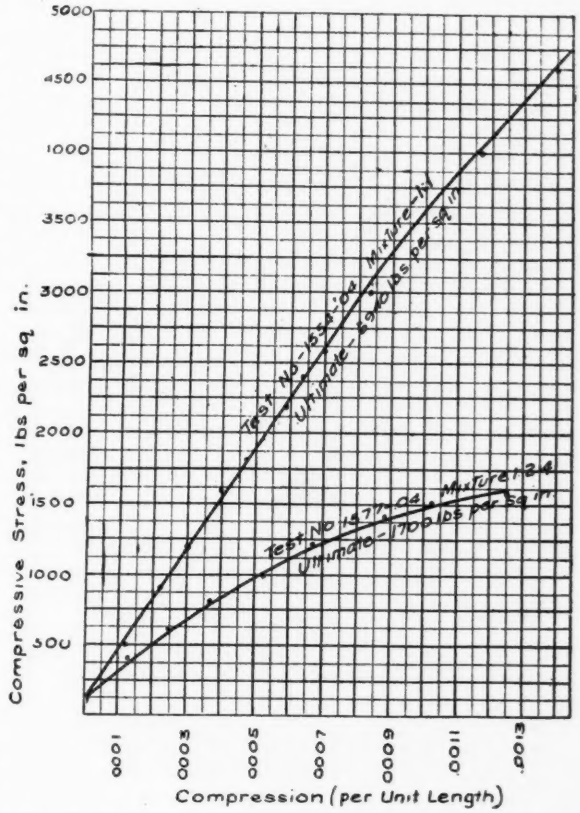



Fig. 1. Behavior of Typical Rich and Lean Mixtures Under Compressive Stress.

longitudinals or as hoops, an efficient and economical method of strengthening compression members? These and other questions that might be asked have been for theorists, an excuse for evasive hypotheses, and for investigators, a stimulus to investigation. In the discussion of efficiency and economy, a knowledge of the elastic and other properties of the materials employed is of prime importance. An ability to interpret the geometrical features of the stress-strain curve is a part of this knowledge, and is therefore very essential.

In Fig. 1 the stress-strain curves for two concrete prisms are shown, the data having been obtained from tests of metals. The upper curve is for a 1:1 cement and sand mortar of ultimate crushing strength, 6,940 lbs. per sq. in. The lower is for a 1:2:4 cement, sand and gravel mixture which failed at 1,700 lbs. per sq. in. It will be observed that while the former continues straight, up to a stress of 2,500 lbs. per sq. in., the latter deflects almost from the start. That

the former is at the outset twice as steep as the latter will be interpreted as meaning that the modulus of elasticity of the richer concrete is nearly twice as great as that of the poorer. That there would be a permanent "set" for relatively small stresses in the case of the latter would be anticipated. As might also be expected, a much closer approach to complete recovery was realized in the other instance after even moderately large stresses.

When two dissimilar materials deform together, it is usually assumed that they take stresses in proportion to their relative rigidities. If, for example, the steel in the longitudinal reinforcing of concrete columns be ten times as rigid as the surrounding concrete, its stress for a given deformation will be ten times that of the concrete. Experiments conducted on columns of concrete of the grade ordinarily manufactured and reinforced in this manner shows that the stresses in the steel, accompanying stresses in concrete of such intensity as is commonly specified, are very much lower than good practice will endorse or economy recommend. In the accompanying table are given some data taken from tests of metals during 1904. In parallel columns are shown simultaneous values of stress in concrete and in steel longitudinals in compression members having from .97 to 2.09 per cent of reinforcing.

Mixture—variable.
Percentage of metal in longitudinals—.97 to 2.09.

| Test No. | Mixture | Average Stress, lbs. per sq. in. | Steel Stress, lbs. per sq. in. | Concrete Stress, lbs. per sq. in. | Steel Stress. / Concrete Stress. | Ultimate Strength, lbs. per sq. in. |
|---|---|---|---|---|---|---|
| 1613 | 1:1:2 | 600 | 3,540 | 556 | 6.4 | 2,890 |
| 1612 | 1:2:3 | 600 | 6,360 | 516 | 12.3 | 2,010 |
| 1582 | 1:2:4 | 600 | 5,040 | 557 | 9.0 | 2,180 |
| 1581 | 1:2:4 | 600 | 5,520 | 549 | 10.1 | 1,990 |
| 1584 | 1:2:4 | 600 | 4,320 | 527 | 8.2 | 2,830 |
| 1579 | 1:2:4 | 600 | 3,780 | 532 | 7.1 | 2,760 |
| 1610 | 1:2:4 | 600 | 5,220 | 532 | 9.8 | 1,820 |
| 1616 | 1:2:4 | 600 | 9,060 | 476 | 19.0 | 2,095 |
| 1608 | 1:3:6 | 600 | 11,100 | 446 | 24.9 | 1,370 |
| 1617 | 1:3:6 | 600 | 4,860 | 516 | 9.4 | 2,290 |
| Average | | | 6,000 | 530 | 11.6 | |

From this table it is seen that the average stress existing in steel longitudinals in columns carrying 600 lbs. per sq. in. over the gross area was only 6,000 lbs. per sq. in. In structural and bridge work, working stresses at least twice this would not be considered excessive. It is undoubtedly true that metal is sometimes employed in structures for emergency purposes, and ordinarily may sustain stresses which are very small indeed, or absent altogether. In the case of concrete columns, this is partly true. To take care of bending stresses due to eccentric loading, or to possible inequalities in the concrete, longitudinal roads are necessary; still if the working stresses in them could be increased somewhat past the limit given in the above table, it could be felt that more of the advantages of the use of the metal were being realized, particularly since, even when stressed to the maximum, which good practice favors, it carries a load in compression at about twice the cost of concrete.

By employing a better grade of concrete, thus permitting the utilization of higher working stresses, a partial remedy is secured. An improvement in quality is, however, accompanied by a marked increase in the elastic modulus as well as in the ultimate strength as is indicated in Figs. 1 and 2, the latter being a typical stress graph for a plain 1:1 concrete of age three months, plotted for a test made by the writer. The aggregate was a hard trap rock, with the fine crusher dust screened out, the size of aggregate varying from ¼ to ¾ in. The member was first stressed up to 2,200 pounds per square inch when the load was released. The magnitude of the "set" is almost insignificant, it being observed that the second

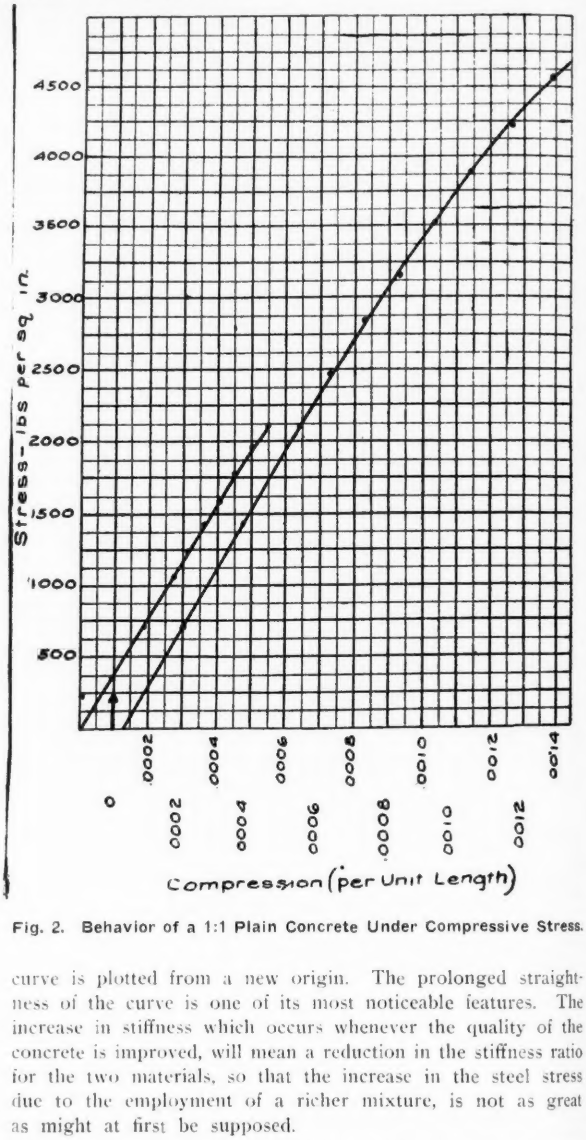



Fig. 2. Behavior of a 1:1 Plain Concrete Under Compressive Stress.

curve is plotted from a new origin. The prolonged straightness of the curve is one of its most noticeable features. The increase in stiffness which occurs whenever the quality of the concrete is improved, will mean a reduction in the stiffness ratio for the two materials, so that the increase in the steel stress due to the employment of a richer mixture, is not as great as might at first be supposed.

Below are given the results of a few impression tests made by the writer on columns of this grade of concrete. The specimens were 6 inches in diameter and 21 inches long.

As the average strength is well over 5,000 lbs. per sq. in., it would seem that a working stress of 1,250 lbs. per sq. in. is not excessive.

To determine the manner in which such material will behave in combination with steel, longitudinally placed, a number of columns were constructed and tested. Nine determinations of the modulus of elasticity for this concrete plain, gave an

Mixture—1:1.
Age—6 months.

| Specimen No. | Crushing Strength, lbs. per sq. in. |
|---|---|
| A | 4,900 |
| B | 5,975 |
| C | 5,150 |
| D | 6,160 |
| E | 4,120 |
| F | 5,480 |
| Average— | 5,300 |

Comparison Tests on Short Columns.

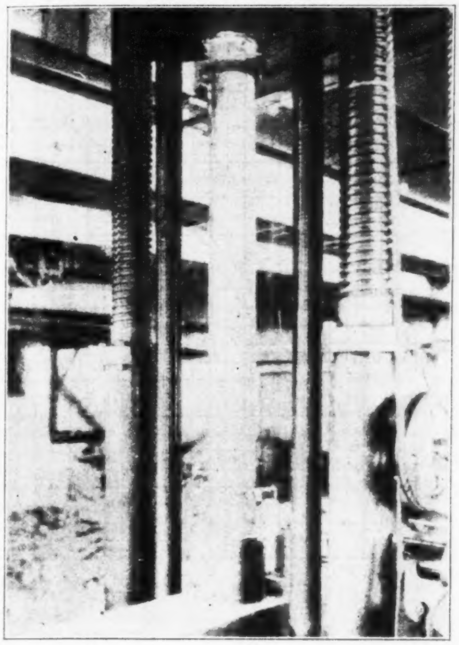


Fig. 3. Column with Longitudinal Reinforcement Under Test.

average value of 3,900,000 lbs. per sq. in., with the smallest value 4 per cent. lower and the largest 4½ per cent. higher than the mean of all. Eight determinations of the elastic modulus in columns, reinforced with from .88 per cent. to 4.42 per cent. of steel, gave an average value of 3,600,000 lbs. per sq. in., showing that apparently the concrete is less rigid in the reinforced column than it is in the plain. In the latter case, the smallest value was 13 per cent. less, and the greatest, 11 per cent. more than the mean of all. The subjoined table shows in a few representative cases, the magnitude of the stress in the longitudinal reinforcement accompanying a stress of 1,250 lbs. per sq. in. in the concrete.

Mixture—1:1.

Percentage of metal—.88 to 4.42.

| Designation. | Stress in Concrete, lbs. per sq. in. | Stress in Steel, lbs. per sq. in. | Steel Stress. / Concrete Stress. |
|---|---|---|---|
| M | 1,250 | 9,300 | 7.4 |
| J | 1,250 | 9,600 | 7.7 |
| H | 1,250 | 10,500 | 8.4 |
| N | 1,250 | 10,500 | 8.4 |
| Q | 1,250 | 12,000 | 9.6 |
| R | 1,250 | 10,800 | 8.6 |
| O | 1,250 | 10,500 | 8.4 |
| P | 1,250 | 10,500 | 8.4 |
| Average— | 1,250 | 10,400 | 8.4 |

Simultaneous Stresses in Concrete and Steel Longitudinals.

On account of the increased working stress in the concrete, the average stress in the steel is substantially greater. The attainment of such stresses, rendered possible through the employment of a better grade of concrete, must be considered a step toward the economical use of steel in concrete columns.

Another matter of some consequence is the amount of "set" taken by the concrete after the stress is relieved. The most satisfactory materials for the purpose of the engineer are those which have for moderate stresses, the power of perfect recovery. Of concrete, as ordinarily manufactured, this can scarcely be said. It will be observed in the table below, that the average "set" for the rich concrete after a stress of 2,000 lbs. per sq. in. is approximately half as great as that of the poorer grade after a stress of half the magnitude. The data was taken somewhat at random from the report of the Watertown arsenal for 1904, but is believed to be fairly representative of the two grades of material.

| After 2,000 lbs. per sq. in. | | | After 1,000 lbs. per. sq. in. | | |
|---|---|---|---|---|---|
| Mixture. | "Set", ins. | Ult. Strength, lbs. per sq. in. | Mixture. | "Set", ins. | Ult. Strength, lbs. per sq. in. |
| 1 : 1 | .0006 | 6,940 | 1 : 2 : 4 | .0028 | 1,210 |
| 1 : 1 | .0013 | 4,800 | 1 : 2 4 | .0020 | 1,700 |
| 1 : 1 | .0014 | 4,360 | 1 : 2 : 4 | .0010 | 1,480 |
| 1 : 1 | .0004 | 6,400 | 1 : 2 : 3 | .0012 | 1,680 |
| **Average** | .0009 | | | .0017 | |

Amount of Set After Release of Stress in Two Grades of Concrete Specimens 12 Inches Long.

The function of hoops in compression numbers is to resist the lateral expansion which accompanies longitudinal compression due to load. For most materials, there is a more or less constant ratio between the lateral and the longitudinal strain. This is known ordinarily as Poisson's ratio, and for most materials of construction is about ⅓ or ¼. Let us assume a concrete column reinforced with hoops and with longitudinal rods. When it is stressed by loading, a longitudinal shortening takes place which sets up stresses in both steel and concrete, the ratio between them being the ratio of their relative rigidities. If the hoops were absent, a lateral expansion would have taken place which, per unit of diameter, would be only a fraction of the aforementioned shortening per unit of length. The hoops reduce this to some extent (otherwise they would not serve their purpose) and consequently the unit deformation in them must be of even smaller extent. From this it is manifest that hoop stress will be very much less than the compressive stress carried at the same time by the longitudinal rods, and if some misgivings are had as to the wisdom of employing longitudinal steel in columns, certainly greater doubt might be entertained regarding the use of hoops. For while the fabrication of hooped reinforcement is usually more expensive than where longitudinal rods are used, the safeguard against bending due to eccentric loads and defective materials locally, is very inadequately afforded.

In the hooped columns, the tests on which are referred to below, a 1:1 mixture of small size trap rock and cement was used. The hoops were welded from steel flats and were of two thicknesses, .05 and .12 inches. The quality of metal relative to the core within the hoops varied from .024 to .057. No longitudinal metal was employed save three strips of thin hoop iron that were employed as spacers for the hoops. In order to measure the stresses in the hoops, certain of the rings were left exposed, partly or completely, and to these, mirror extenso-meters were attached. Longitudinal deformations were measured by means of compressometers fixed to a gauge length of about 50 inches. In the curves of Figs. 4 and 5 an opportunity to see the manner in which the steel stress varies with the compressive stress in the concrete is afforded. In every case, as the concrete was subjected to higher compressive stresses, a tendency on the part of the curve to deflect downward manifested itself. In some cases, the curve became parallel with the axis of steel stress. This would indicate that the concrete under high compressive stresses had reached a stage of partial plasticity within the hoops. The fact that on release of load after heavy stressing, the extensometers did not usually completely recover, would indicate that this apparent tendency to flow had left the steel in a state of residual tension, since usually the steel stress had not even approached the elastic limit. In Fig. 5, the continued increase in steel stress under a constant load is shown.

From purely theoretical considerations if the elastic properties of the materials and the quantity of hooping present are known, it is possible to establish a simple relation between the compressive stress in the concrete and the accompanying

stress in the encircling bands. In the evolution of the equation which follows, the stiffness ratio for this material was assumed to be 9. A number of determinations of Poisson's ratio gave ¼ for an average value. For these materials, it can be shown that fs:fc::9:4+9/2p where fs is stress in steel bands fc is axial compressive stress in the concrete and p is the ratio of metal concrete within the bands. Since p is usually small with respect to the other numbers involved, it follows

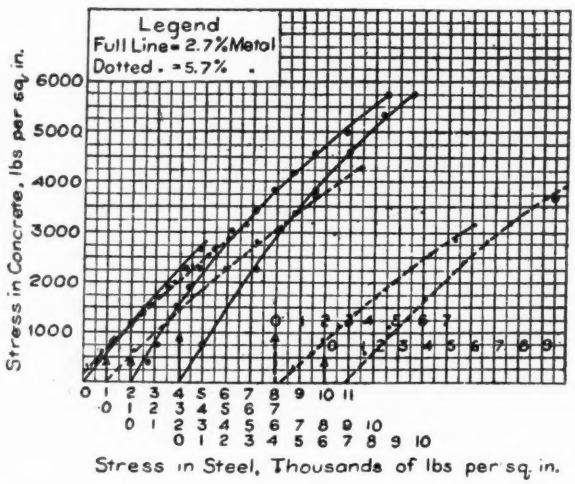



Fig. 4. Ratio of Steel Stress to Axial Compressive Stress in Hooped Concrete Mixture 1:1.

that the usual changes which p might undergo do not affect the ratio fs:fc in a very conspicuous way. In Fig. 6, the manner in which the ratio changes consequent on variation of p is shown. The joints plotted adjacent to the curve show to what extent the theoretical investigation agrees with the results of experiment. In the following table are given a few simultaneous values of hoop stress and compressive stress in concrete. The figures are representative of a somewhat large number of determinations and broadly speaking show, as is indicated on Figs. 4, 5 and 6, that for the materials employed, the hoop stress is approximately twice that in the concrete.

Tests made by Professor Talbot in 1907 on hooped concrete columns using a 1:2:4 mixture showed that the ultimate strength was increased about 570 lbs. per sq. in. for each per cent of hooping employed. Similarly, tests made at the Watertown Arsenal in 1906 show that one per cent. of metal in the form of hoops increased the strength of the member to the extent of 1,020 lbs. per sq. in. Professor Withey, in 1909, reported that for each per cent. of metal employed in the form of spiral reinforcing, the increase in ultimate strength on an average was 1,320 lbs. per sq. in. for 1:2:4 concrete. In most cases the strength of the columns tested by the writer exceeded the capacity of the testing machine employed. In one instance, where the column had 2:4 per cent. of steel in the form of hoops, the ultimate strength was 7,660 lbs. per sq. in. This, it will be observed, is equivalent to an increase in strength over plain concrete of 1,000 lbs. per sq. in. for each per cent of metal. The manner of failure is shown in Fig. 8. From these and other tests which might be cited, a generous allowance for hooping would be 1,000 lbs. per sq. in. gross strength for each per cent. of metal employed. Tests conducted on hooped columns reinforced also with longitudinal rods indicate that greater efficiency is obtained from the rods than when employed without the hoops.

A comparison of costs between the rich mixture concrete column, carrying light longitudinal reinforcement, and a hooped structure of estimated equivalent ultimate strength is interest-

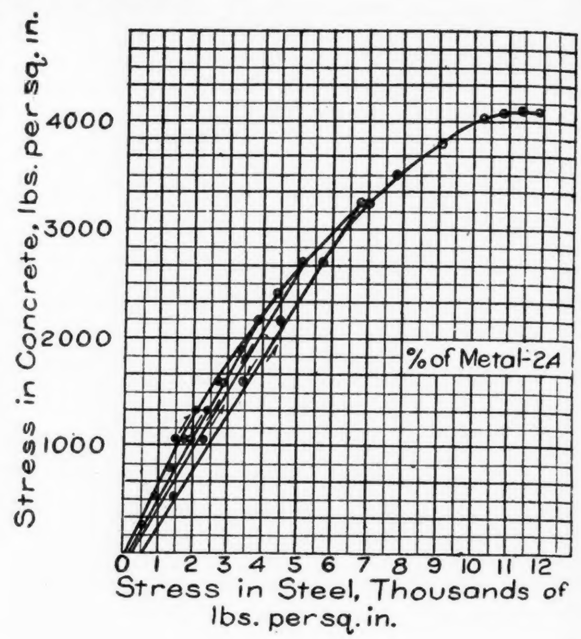



Fig. 5. Behavior of 1:1 Hooped Concrete Repeated Compressive Stresses.

**Simultaneous Stresses in Concrete and Steel Hoops.**

Mixture—1:1.

Percentage of metal in hoops—2.4 to 5.7.

| Concrete Stresses, lbs. per sq. in. | Hoop Stresses, lbs. per sq. in. | p. | Steel Stresses. / Concrete Stresses. | State of hoop. |
|---|---|---|---|---|
| 2,400 | 5,500 | .057 | 2.28 | Partially exposed. |
| 3,000 | 7,000 | .024 | 2.30 | Completely exposed. |
| 1,900 | 4,300 | .057 | 2.26 | Partially exposed. |
| 2,300 | 5,000 | .057 | 2.18 | Partially exposed. |
| 2,000 | 4,700 | .057 | 2.34 | Partially exposed. |
| 3,000 | 6,000 | .057 | 2.00 | Partially exposed. |
| 3,250 | 4,000 | .057 | 1.23 | Completely exposed. |
| 2,600 | 5,000 | .024 | 1.92 | Partially exposed. |
| 2,300 | 5,000 | .027 | 2.17 | Partially exposed. |
| 2,800 | 5,000 | .024 | 1.77 | Completely exposed. |
| 2,750 | 5,000 | .027 | 1.82 | Completely exposed. |
| Average— | | | 2.02 | |

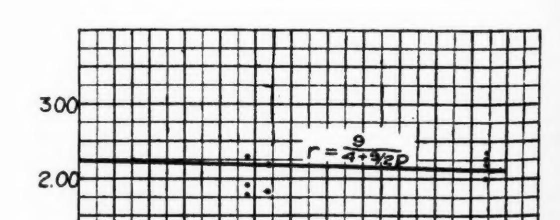



Fig. 6. Ratio fs:fc with Change in Percentage f Metal in Concrete Mixture 1:1.

ing. The materials laid down have been assumed to cost as follows:

| | |
|---|---|
| Cement | $1.50 per barrel |
| Aggregate | $2.00 per cubic foot |
| Sand | $1.00 per cubic foot |
| Plain reinforcing | 3c per pound |
| Hooping, fabricated | 5½c per pound |

For a 1:1 cement and rock mixture, the cost per cubic yard will be:

| | |
|---|---|
| Cement | $ 8.10 |
| Rock | 1.58 |
| Labor | 2.00 |
| Plain steel, ½ per cent. | 2.03 |
| Total | $13.71 |

Since the metal is added chiefly as emergency material, it will not be figured in the ultimate strength which will be taken at 5,000 lbs. per sq. in. A 1:2:4 concrete (the ultimate strength of which plain may be assumed at 2,000 lbs. per sq. in.) will be rendered equivalent in strength to the 1:1 mixture by the use of 3 per cent. of hooping metal. The cost per cubic yard will then be:

| | |
|---|---|
| Cement | $ 2.53 |
| Rock | 2.00 |
| Sand | .50 |
| Steel hoops | 22.28 |
| Labor | 2.00 |
| Total | $29.31 |

In addition to the greater cost, this column will not possess the stiffness and probably not the margin of safety against bending stresses which are found in the cheaper column.

In order to compare the areas of three different types of columns, and their cost per foot of length, it will be assumed that a 10-story building with dead and live floor loads at 200 lbs. per sq. ft., and a roof load of 100 lbs. per sq. ft. is to be constructed. Assume also square floor bays of 15-ft. to a side. It will be seen that the load sustained by a column on the ground floor will be 427,500 lbs. This may be carried:

(a) By a structural steel column.
(b) By a column of the poorer grade of concrete.
(c) By a column of the richer mixture.

A reference to the Carnegie handbook, p. 141, shows that a steel column consisting of two 10-in. channels and two ⅞-in. plates will be adequate. This column weighs 121 lbs. per running foot. The cost per foot of height will be:

| | |
|---|---|
| Steel at 5c per lb | $6.05 |
| Fireproofing, 2 in. thick | .58 |
| | $6.63 |

A 1:2:4 concrete column with 1 per cent. of longitudinal metal will be figured at 450 lbs. per sq. in. for the concrete, and $450 \times 15 = 6{,}750$ lbs. per sq. in. for the steel. The average stress will, therefore, be $450\ (1 \times .14) = 513$ lbs. per sq. in. The gross area required will be $427{,}500 \div 513 = 833$ sq. ins. Hence a column 29 ins. square will be adequate. Allowing one inch additional for fireproofing, we have a column 30 ins. square, the cost of which, per foot of height, would be:

| | |
|---|---|
| Concrete, including 1 per cent. steel and labor | $2.55 |
| Forms | .46 |
| Total | $3.01 |

The third method employs a 1:1 mixture, the working stress on which will be taken as 1,250 lbs. per sq. in. The area required will be $427{,}500 \div 1{,}250 = 342$ sq. ins. This is the area of a square of 18.5 inches to the side. Allowing 1½ ins. for fireproofing, we obtain a column of 20 ins. square, the cost of which per foot of height with ½ per cent. of longitudinal steel would be:

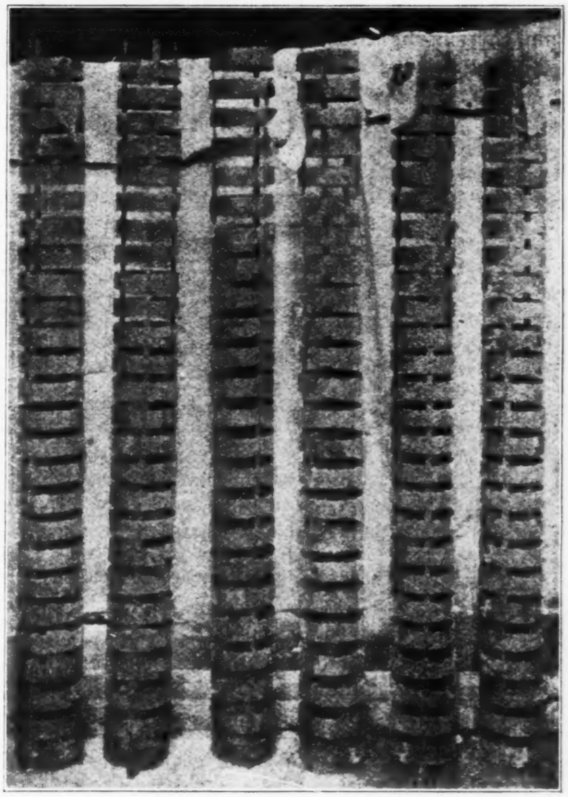


Fig. 7. Hoop Reinforcement Ready to Place in Forms.

| | |
|---|---|
| Concrete, including ½ per cent. of steel and labor | $1.30 |
| Forms | .32 |
| Total | $1.62 |

The areas of the cross-sections in the three cases are:

(a) 1.8 sq. ft.
(b) 6.3 sq. ft.
(c) 2.8 sq. ft.

It is thus seen that the difference between the smallest cross-section and the largest is 4.5 sq. ft., an item of considerable importance in districts where the rental of floor space is high. On the other hand, the difference in cross-sectional area between the most expensive method of carrying the load, and the cheapest is 1.10 sq. ft. Having regard then to the fact that the rich mixture column costs only one-fourth as much as the steel structure, there would seem to be a good deal to be said in favor of the stronger mixture.

The writer desires to state that of the experimental work referred to above, part was conducted in the testing laboratory of McGill University in Montreal, and part in the laboratory of applied mechanics in the University of Toronto, the former being done under the general supervision of Professor E. Brown, of the Department of Civil Engineering.

The consideration of the reader is invited to the following inferences to which an examination of the data at hand seems to lead. Since the experimental evidence supporting these conclusions is, in the opinion of the writer, scarcely extensive

enough upon which to base broad generalizations, they are not advanced as being final and conclusive.

1. The rich mixture is more uniform in its elastic properties than the lean mixture, and for proportionate stresses, the permanent set is likely to be very much less. The parabolic feature of the stress-strain curve is also less noticeable.

2. The employment of a rich mixture of columns permits of the more economic stressing of the steel longitudinals. It is very probable that a strength equal to that obtained by the use of a mixture can be secured by the careful grading of the aggregate, and the use of less cement.

3. The experiments cited indicate that, for the materials employed, the stress in the steel hoops was approximately twice the axial compressive stress in the concrete core. The steel is consequently not economically employed.

4. Theoretically and experimentally, the variation in the relation of steel stress to axial compressive stress does not vary greatly with variation in the percentage of metal.

5. A given ultimate strength can be more cheaply secured by a rich mixture lightly reinforced by longitudinals than by the utilization of hooping. The former also secures greater rigidity and safety against bending.

6. For equal safe loads on columns, the lean mixture is probably intermediate in cost between the steel column and the rich mixture lightly reinforced by longitudinals, the latter being the cheapest.

7. The cross-sectional area of the steel column is least for a given loading, and the lean mixture greatest. The difference between the cross-sectional areas of a steel fireproofed column and a rich mixture concrete column is the least of all.

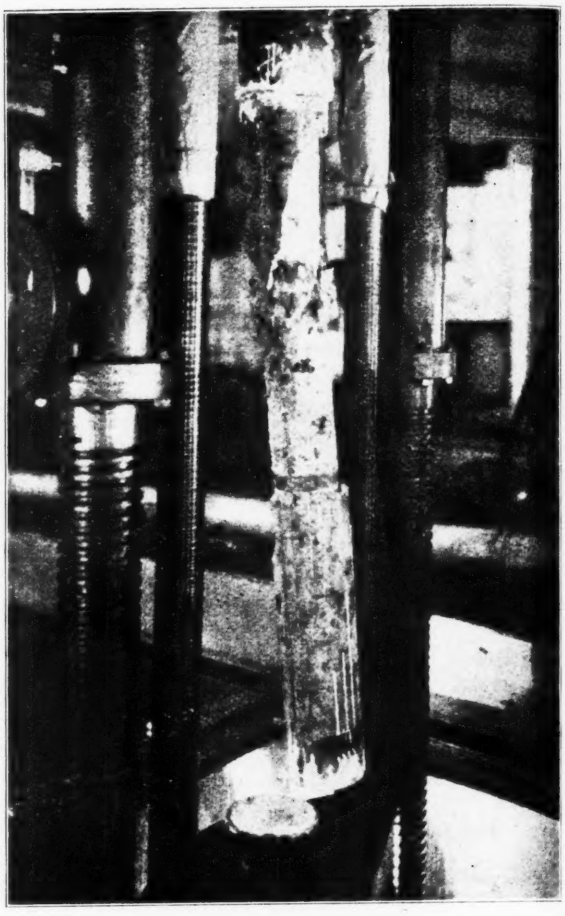


Fig. 8. Failure of Hooped Concrete Column. Three Hoops Nearest Center Burst.

## Speed Control Signals *

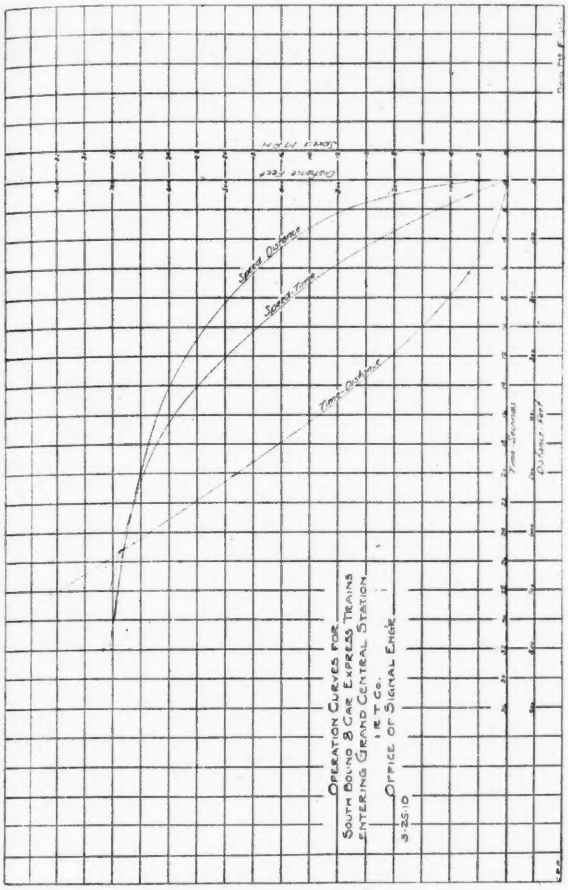
Speed control signals are intended to compel trains to observe certain fixed predetermined speeds. They can be used on curves or at points where it is necessary to reduce the train speed to a certain fixed maximum limit. In the New York subway of the Interborough Rapid Transit Company, they are used on approaches to stations and on approaches to junctions: at junctions, to permit a train to approach under controlled speed near to the junction at a time when another train is passing over the junction: at stations, to permit a train to approach near to the station at the time the track in the station is occupied by another train.

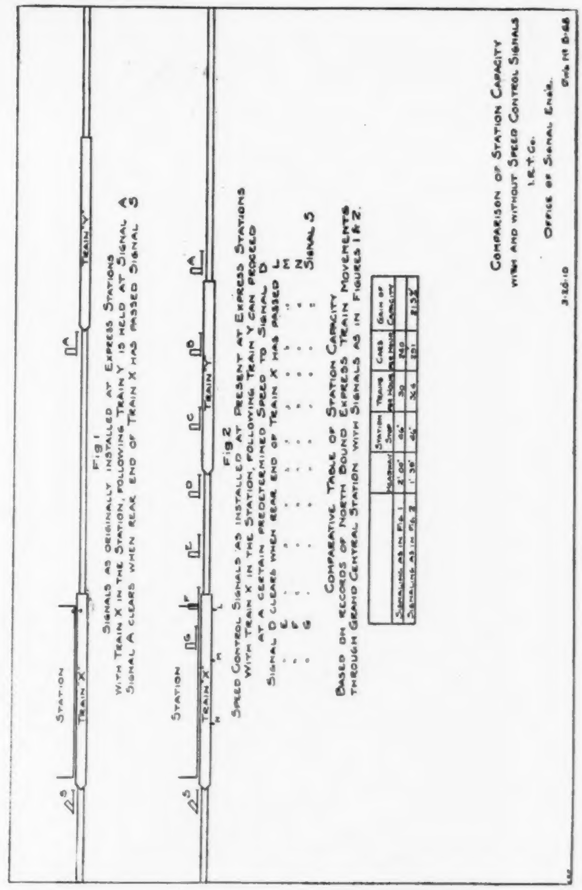
Block signals in the New York subway are automatic. Interlocking signals are semi-automatic. Operating in connection with these signals are automatic stops. These stops are for the purpose of applying the brakes on trains automatically should the motorman disregard the stop indication of the signals. The successful operation of the automatic stop requires the use of overlapping track circuits; and the length of such overlap must be more than the braking distance of a train when moving at its maximum speed. That is, the distance between signals "A" and "B" must be equal to the stopping distance of a train, if such train when running at maximum speed should be tripped in passing signal "A."

Subway cars are equipped with very efficient brakes. Tests have shown that a ten-car train, weighing more than 900,000 pounds, when running at a speed of forty miles an hour on a 3.1 per cent descending grade, was brought to a stop inside of 700 feet. With brakes so efficient, what is the object of bringing trains so close together? Surely 700 feet is not an excessive distance to keep trains apart; the time consumed in running this short distance ought not to materially interfere with the traffic of a railroad. The necessity of saving seconds in train operation on the roads of New York City will be better understood when it is realized that one-fifteenth of the population of the whole United States lives within twenty miles of the City Hall of New York; and this population is increasing at a greater rate than that in the rest of the country. This population has many business interests and the great volume of its business centers in the lower part of Manhattan Island. This concentration of business brings the resultant concentration of traffic, which is congested to such an extent that it could hardly be worse. I will not attempt to describe in detail what each railroad engaged in the transportation problem in New York City is doing, but will assure you that the company I represent, the Interborough Rapid Transit Company, is doing all it can towards carrying this vast multitude. The number of trains, the number of cars, the car mileage and the number of people carried for the whole city for one day, I do not know; but I do know that the lines of the Interborough Rapid Transit Company, which include the elevated roads of the boroughs of Manhattan and the Bronx, and the subway in the boroughs of Manhattan, Bronx and Brooklyn, operate 29,254 cars made into 4,236 trains, carrying about 2,000,000 people, each twenty-four hours.

While the population is increasing very rapidly, the traffic is increasing much faster than the population. Statistics show that the traffic doubles every ten years. Statistics also show that whatever has been done and whatever is being done to increase the traffic facilities of the city, the traffic

* Paper by J. M. Waldron, Signal Engineer, Interborough Rapid Transit Company, New York City.




requirements more than discount such increases long before they are finished.

You may say this transportation question can be successfully handled; that all that is wanted is to work at it in a systematic manner; build enough new roads to take care of the present congested traffic and extend these as the traffic requirements warrant. Yes, that is the legitimate solution of the problem and the men who are actively engaged in handling the transportation of this city, are united in saying that that is the only solution of the problem; but up to the present time it has been found impossible to put such a scheme into operation. There are many obstacles in the way of adequate traffic development in the city of New York. The cost of construction is vast. The foundations of the high buildings which line the streets must not be interfered with. The great street traffic must be kept going and all that vast network of gas, water, steam and pneumatic pipes, sewers, electric light and power, telephone and telegraph conduits and underground electric trolleys must not be hampered in any manner or form. The great crowds of people on the streets and the places of business along the streets must be protected at all times; in fact, so many obstacles must be overcome that capital hesitates a long time before undertaking an enterprise of this character.

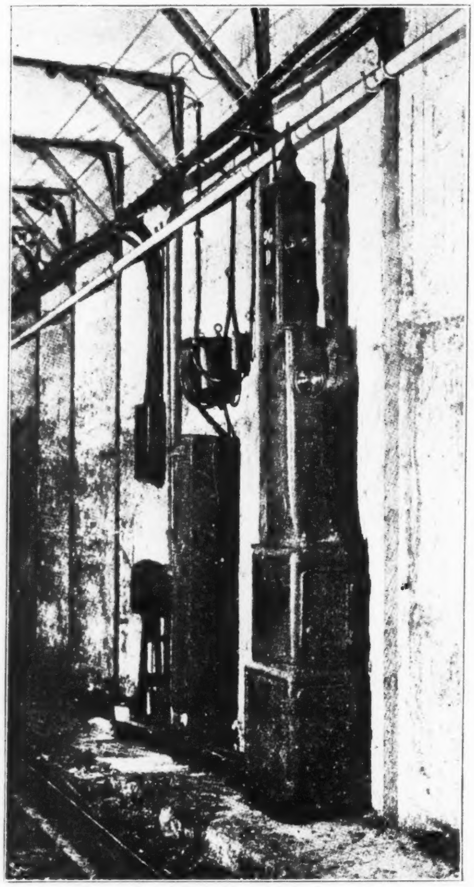
The Interborough Rapid Transit Company, realizing that for the time being it was impossible to immediately build additions to the subway lines devoted its energies to increasing the carrying capacity of the present roads to their utmost limits. The question of building reservoir stations was seriously considered, and the influence such stations would have on increasing the capacity of the roads was carefully worked out. The building of additional tracks at congested points was considered, and the per cent increase of capacity which these additional tracks would give was calculated. But owing to the cost and to the great difficulty of doing this work in a crowded city, while at the same time, the operation of more than 1,900 subway trains a day must not be interfered with; in fact, so many obstacles were met with that these schemes were given up and another solution was sought. That solution was the devising and installation of speed control signals.

The length of the station stop is determined by the time consumed in the unloading and loading of trains. This is practically a fixed quantity. While everything possible is done to reduce this stop, it is found that there is a fixed minimum under which it is impracticable to go.

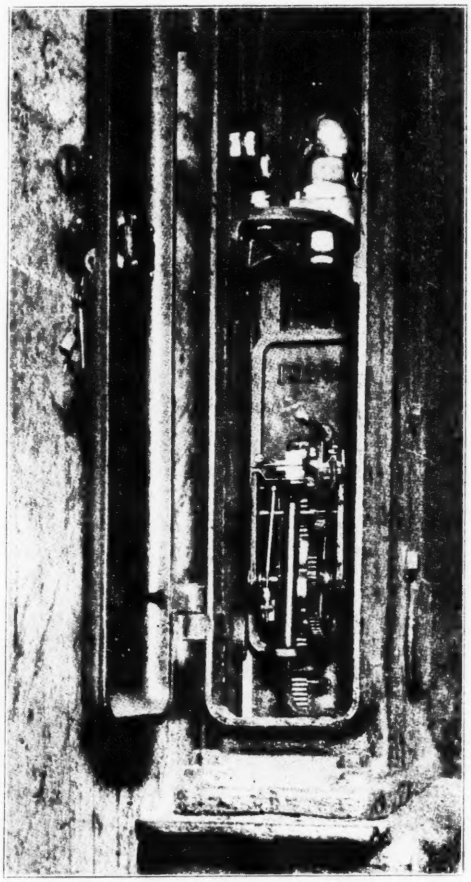
Prior to the installation of the speed control signals, the spacing of trains was such that the front end of train "Y," Fig. 1, when approaching a station, was always held back from the rear end of train "X," Fig. 1, standing in a station, a distance sufficient to allow room in which to bring train "Y" to a stop before its front end reached the rear end of train "X."

The automatic application of the brakes keeps trains the stopping distance apart. Under this system it was impossible to operate trains at a headway of less than two minutes.

Speed control signals operate and control trains in the following manner: Train "X," Fig. 2, is standing at a station platform, signal "A" is at caution and signals B, C, D, E, F and G are at stop indication, automatic trips at signals B, C, D and E are at the stop position, trip at signal "A" is clear; signal "B" is located at braking distance from rear end of train "X." When train "Y" passes signal "A," this signal



Speed Control Signal and Instrument Case.



Timing Signal.

immediately goes to the stop position; when it reaches that position it starts in operation a timing device which makes contacts, after a fixed time, which clear signal and stop "B," provided blocks B, C, D and E are clear. This timing device is so adjusted that the motorman must reduce the speed of his train an amount sufficient to consume a predetermined time interval in running from signal "A" to signal "B." After the front end of train "Y" passes signal "B," this signal goes to the stop position at once and starts a timing device in operation which closes the circuits controlling signal and stop "C" and will clear them provided blocks C, D and E are not occupied. The timing device at signal "B" is so adjusted that train "Y" must take a fixed predetermined time in moving from signal "B" to signal "C." If train "Y" travels this distance in less than the allotted time, its front end will reach signal and stop "C" before they have cleared, with the result that the train will be tripped and brought to a stop automatically; and as train "Y" has been compelled to reduce its speed in moving from signal "A" to signal "B," its speed is now sufficiently low to bring it to a stop before it reaches rear of train "X," even though its braking distance is much reduced. Train "Y" can now proceed to signal and stop "D," where it is held until train "X" starts to move out of the station. When rear end of train "X" has passed "L" signal and stop "D" clears. Train "Y" now continues on to signal "E." This signal will not clear until rear end of train "X" has passed "M." It then clears and train "Y" can proceed to signal "F." This signal and stop will clear when rear end of train "X" has passed "N." Train "Y" can now move to signal "G," which will not clear until rear end of train "X" passes the exit end of the platform.

Signals A, B, C, D, E, F and G are so located that train "Y" can continue to move in towards the station without interruption, while train "X" unloads and loads its passengers and moves out of the station. Thus, the time consumed in stopping and starting is eliminated. If there should be no train in the station when train "Y" approaches, all signals will be clear and train "Y" can enter station without reducing speed; if train "X" should leave the station when train "Y" is approaching under control, all signals between train "Y" and the station will immediately show the clear indication when "X" leaves the station. Fig. 3 shows time and speed curves for "Y" entering a station.

A manager of a prominent Western road visited us a short time ago. He looked at everything in the power-house, watched those great engines and generators silently moving, each one doing the work of 20,000 horses, and all without noise or fuss. This, of course, impressed him very much. He then went to different parts of the road, such as the stations, and saw train after train pass through, each one letting off and taking on passengers, all trains crowded and yet the platforms remained crowded. He saw the vast stream of humanity, going and coming, which never ends. He examined the brake equipment, the multiple unit control, the ventilating system of the tunnel and of the tubes under the river, the emergency fire-alarm system and the fire-fighting system. All these were interesting and instructive. He was then taken to the approach of an express station and watched the operation of speed control signals. He watched a train go by, enter the station and stop; he saw another train approach, the signal stood there mute, the red light telling the motorman "you may come to me, but must not pass, or I will stop

your train." He saw the motorman slack his train's speed, then in a little while the signal turned to life and beckoned to the motorman "come on, you can go by me, but you obey my orders and reduce your speed, or I will see that your brakes are applied before you get along very far and that your train is brought to a stop before you hurt those people in the train ahead of you, or any of the people in your own train." The manager opened his eyes wide, turned to his companion, looked at him, then said, "Say, those things have brains; come on, let's get out of this. I am going back out West; if I stay here any longer I shall be seeing things."

The following is a comparison of capacity of trains operating under the old system and trains operating under the speed control system, based on records on northbound express train movements through Grand Central station: Under the old system, the headway between trains was two (2) minutes, station stop 46 seconds; trains per hour 30, cars per hour 240. Under the speed control systems, headway between trains 1 minute 39 seconds; station stop 46 seconds, trains per hour 36.4, cars per hour 291. Gain of capacity on road 21.3 per cent, that is, the capacity of the road was increased a little over one-fifth.

## The World Signal

J. H. Wisner, Jr.

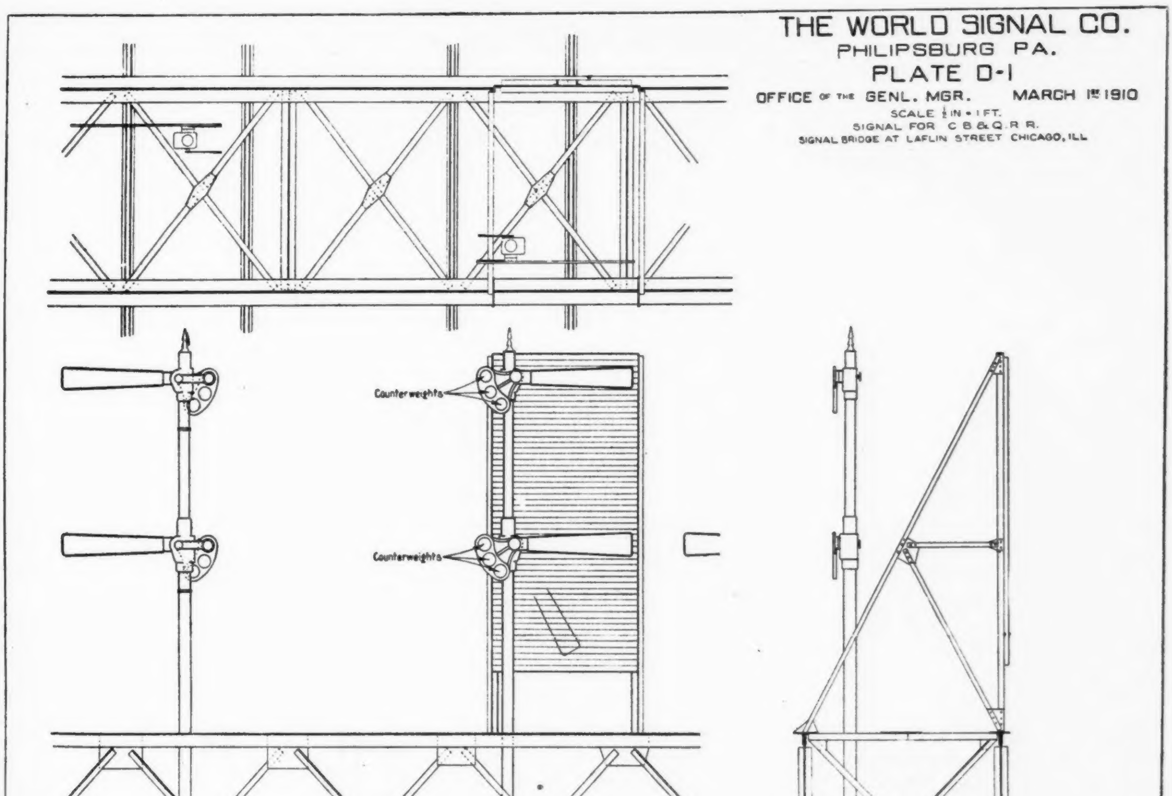
In its inception this signal consists of a low semaphore post carrying one or more arms, mounted before a white screen or background, with a space of several feet between. A lantern of special design is attached to the back of the post and the light is showered on the background in a greatly intensified form through the use of a reflector of special design within the lantern. The screen being white, a bright background is secured at night, against which the semaphore arm is seen in a striking silhouette.

Experiments have shown that it is not necessary to have a background of exceeding whiteness nor an illumination of high power in order to make the semaphore visible at a great distance. A small flame produces in effect a moon light of phosphorescent appearance upon the screen against which the signal indication is plainly visible at several thousand feet.

During the development of the signal many experiments were performed to convince ourselves and our spectators of this point. In front of the screen of pure white two curtains were arranged in such manner that one at a time could be lowered. Curtain No. 1 was of a pearl gray, or such a color as a white screen might be expected to take on after being exposed to the smoky atmosphere in the vicinity of yards and terminals. Curtain No. 2 was of a dark slate color, representing a screen very badly soiled. Our present method of constructing the background, which will be described later, largely obviates the difficulties of discoloration by smoke and settlement of dust, but the experiments with the tinted curtains proved slight discolorations to be not very seriously detrimental.

With curtain No. 1 in place and no additional illumination, the indication was not perceptibly impaired. The silhouette against the curtain was very impressive.

With curtain No. 2 in position, the indication could be seen at a considerable distance with astonishing distinctness. How far we have anticipated in these experiments the obstacles to be coped with later, will be known when more of the signals have been put in operation. However, one



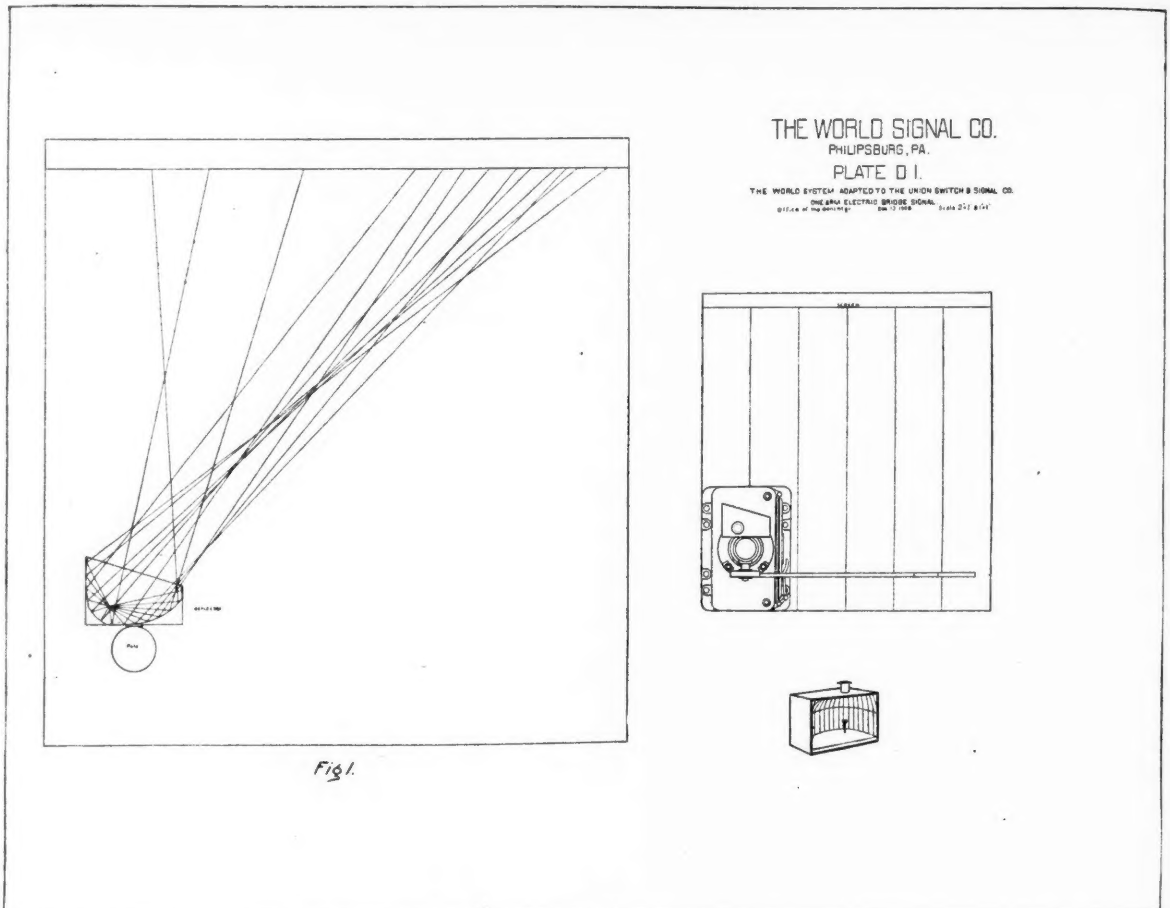



Fig 1.

signal which stood near the roundhouse in Tyrone, Pa., for the better part of a year, where it was continually in an atmosphere of smoke, was not sufficiently discolored noticeably to impair the aspect either by day or night.

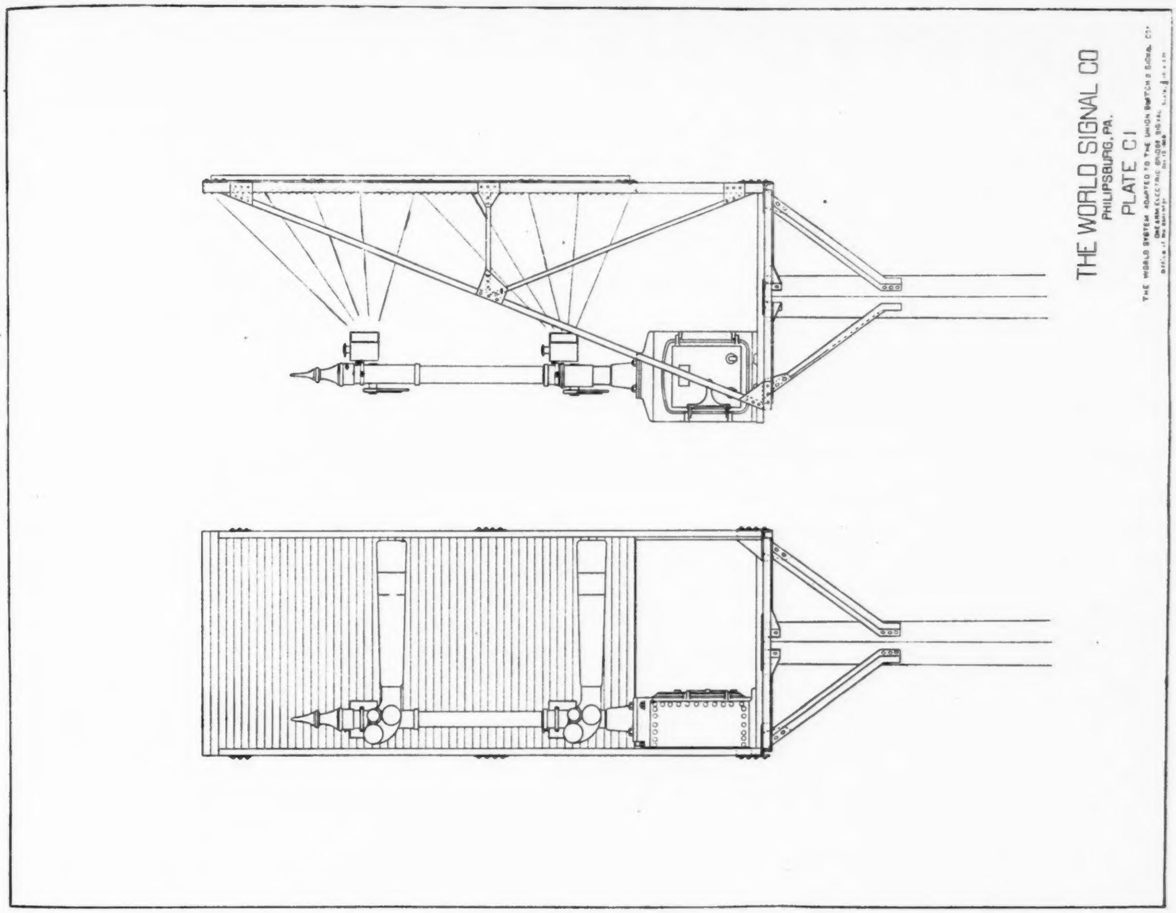
In order to secure a background against which all parts of the signal, in whatever position, will appear with equal distinctness, it is necessary that the screen be uniformly illuminated throughout its area. This result is obtained by the use of a reflector composed of small panels within the lantern. These panels, or faces, are placed at such an angle with each other and with the light, that a particular region of the screen is illuminated by the reflected light from each panel. In this way the whole screen is allotted in sections to the different faces of the reflector. That portion of the screen most distant from the lantern would receive least illumination from the direct rays of light, due to its greater remoteness and to the more acute angle at which the rays impinge upon the surface. For this reason the portion of screen to be illuminated by one reflector panel is smaller in this region, causing a greater concentration of reflected light on the part of the screen which receives the least direct rays. Fig. 1 shows a plan of the reflector, the screen, and the rays of light.

The screen referred to in the foregoing description consists of a strong steel frame, with a surface composed of 3-inch wide strips, running horizontally across, but the surface of each being placed at an angle of about 20 degrees with the vertical, their position not being unlike the slats of a Venetian blind, with the strips facing downward toward the front.

The benefit derived from this design is the reduced pressure exerted upon such a surface by the wind. A secondary advantage which accrues is that the surface, by facing downward, reflects the light toward the track with greater intensity than in any other direction. Moreover, any settlement of dust or smoke from the atmosphere must lodge only on the back of the strips.

Some time ago a test of the World Signal was to be made near Tyrone, Pa. On the night appointed for the trial, about a score of superintendents, road foremen of engines, enginemen, etc., were present. There was a driving fog and drizzle. The inspectors gathered at the rear of a train which started at the signal and ran up the track so that the signal was facing the spectators. The standard colored lights were in position on the signal. As the distance became greater the lights were lost to sight, having been obscured by the driving storm. The green, the red, the white, disappeared in the order named, and when the white could no longer be seen the position of the signal arm was still visible.

It is the opinion of the writer, and one which has been corroborated by statements from a large number of locomotive enginemen, that the majority of all enginemen endeavor to discern the position of the signal arm when passing the semaphore at night, far greater reliance being placed upon this indication than upon the lights even among men who believe their vision to be entirely normal. In such a case it would appear to be the dictate of common sense to help these men in the way that by their actions they indicate would be acceptable; and thus mitigate an evil in signaling, the existence of which will not be denied by even the most conservative.




Men who could not tell one light from another have been found at the throttle of locomotives. Such men have run engines for years and have made no mistakes. This is a proved fact. How is such a thing possible? There is just one explanation, and I say it with all possible emphasis. These men, together with others afflicted in a lesser degree, have been seeing the semaphore arm. It may have been necessary to slow the train down when the night was dark or to take risks when this was impossible.

Now the World Signal blade can be seen, not only while passing it, but at many thousand feet down the track. An engineman need have no special faculty to read it. No fatigue or disorder could make it appear other than it is, other than the old signal arm to which the engineman has been accustomed throughout all his railroad experience.

This signal cannot be confused with other lights along the right of way. Missiles can only with difficulty impair its usefulness by extinguishing its light, but cannot alter its indication. Smoky or foggy atmosphere, if sufficiently dense, might render it less far-reaching in its warning, as with all signals, but it could not alter the import of its message. The signaling on all roads is harmonized by the use of it, and no change of system is necessary at night and morning.

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Lewis W. Baldwin, engineer maintenance of way of the Illinois Central, with office at Chicago, was born in Waterbury, Md. He graduated in civil engineering at Lehigh University with the class of 1896, and entered the engineering department of the Illinois Central at once. He was appointed track supervisor of the Illinois Central in 1900, roadmaster of the Yazoo & Mississippi Valley in 1901, roadmaster of the Illinois Central in 1902, and was promoted to trainmaster in 1904. He was transferred to a similar position on the Indianapolis Southern in 1905, promoted to superintendent of that road in 1906, and made trainmaster of both the Illinois Central and the Indianapolis Southern in 1908. In November, 1908, he was appointed superintendent of the Yazoo & Mississippi Valley, the position he held until his recent promotion.

S. D. Warren, signal inspector on the Chicago, Milwaukee & Puget Sound, has been appointed assistant signal engineer, with office at Tacoma, Wash.

John Leisenring, assistant engineer, road and track, of the Hudson & Manhattan, has been appointed signal engineer, with office at Tacoma, Wash.

R. H. Howard, whose resignation as engineer maintenance of way of the Chicago & Eastern Illinois has been announced in these columns, will enter private business in New York.

F. J. Bauman, assistant supervisor of signals of the Pennsylvania Railroad, at Harrisburg, Pa., has been appointed supervisor of signals of the Renovo division, at Renovo, Pa.

M. J. Carrigan has been appointed district foreman of the Oregon Short Line and the Southern Pacific lines east of Sparks, Nev., succeeding W. E. White, assigned to other duties.

Mr. H. E. Cline has been appointed assistant engineer for the Hall Signal Co., with office at Garwood, N. J. Mr. Cline started 12 years ago with the Pennsylvania R. R. Co. on signal construction work, serving in several positions with that company and with the Union Switch & Signal Co., General Railway Signal Co., and the New York Central. He entered the employ of the Hall Signal Co. as draftsman, was promoted to chief draftsman and then to the position he now holds.

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.
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## Track Maintenance

We publish in another column, a paper on track maintenance in New England, together with the discussion provoked. There are many points of great interest to track men in this and we would be glad to hear from our readers on the subject, thus enlarging the discussion. More especially would we like to hear about the maintenance of joints. Also there is the matter of proper drainage of cuts. The assertion is made that cinders are a great help, and from the argument, this seems reasonable. We would, however, like to know more about it. Any letters dealing with these subjects will be published in our Maintenance of Way Department and handled in the usual manner.

## The Railway Signal Association

A report of the proceedings of the Railway Signal Association at New York will be found in another column. This meeting was remarkable for the large amount of work accomplished. It is to be regretted, nevertheless, that the discussion of the progress report of Committee No. 4 on automatic block signals was so badly slighted, especially that part dealing with relays. There was matter for prolonged discussion and much valuable information should have been forthcoming. The two papers read will be found elsewhere. Suffice it to say that the one by Mr. Waldron, on speed control signals, is the first public description of a system of signaling which has proved of inestimable value to the Interboro Co., and which, as time goes on, will prove of equal value to other railways suffering from congested traffic.

## Specifications for Reinforcement Bars

The specifications recently adopted by the manufacturers for concrete reinforcement bars is a valuable contribution to the art of building. Something of this sort has been needed for a long time. The fact that some parts are a trifle vague will not detract permanently from the value as a whole.

## Operation of Switches and Signals

By way of contrast to the report for America on this subject, published last month, we print the report for several European countries. It will be noted that European practice differs radically from ours in many respects. It is our opinion from a careful study of this document, that European railways are markedly deficient in the matter of semi-automatic protection and the use of electrical auxiliary apparatus. Of course, it is well known that they depend upon discipline at many points where we depend upon a machine, yet it would seem to an American railway official as though Europeans are willing to take a great many unnecessary chances.

## Signal Department

The automatic block signal standards of the Boston & Albany are published this month. All their new work conforms in general to the modified scheme of uniform signaling recommended by Committee No. 1 of the Railway Signal Association; note the staggared marker lights. This road has in service yet some of the old clockwork banner signals as well as various other types, including two arm, two position lower quadrant motor signals; but on all new work the three position, upper quadrant type is used. Many old signals on double track are overlapped where no distant signal is provided, but this practice has been discontinued as well as that of placing the signal in advance of the setting point so that the engineman could see it change from proceed to stop. Modern high speeds, and the possibility of a train backing into a block just at the moment another train was about to pass the signal has made such an arrangement undesirable.

Among the features of special interest may be mentioned the use of low voltage line control and the lack of dependence on relays for shunting the track. The trunking clamp for battery wells is a device of great value that has heretofore not generally been applied. Also, the control circuits for power operated semi-automatic signals is worthy of some thought. It will be noted that track circuits nearly a mile long are used. This practice must show a marked economy over the comparatively short sections used by many roads and the ability to maintain such sections would seem to indicate a high class of discipline, excellent ballast and freedom from interference by foreign currents.

The standards were gotten up by Mr. Fitzgerald, formerly signal engineer, and Mr. Elliott now signal engineer in charge of construction of the New York Central Lines east of Buffalo.

L. C. Hartley, engineer maintenance of way of the Chicago & Eastern Illinois, with office in Chicago, was born December 29, 1871, near Morgantown, W. Va. He attended the Ohio State University from 1896 to 1898 and entered railway service in August, 1898, as signal repairman on the Pittsburgh division of the Pittsburgh, Cincinnati, Chicago & St. Louis. He remained with this company until September, 1907, holding positions on the engineering corps and later as assistant engineer maintenance of way. Since September, 1907, he has been signal engineer of the Chicago & Eastern Illinois, the position from which he is now promoted to engineer maintenance of way.

R. H. Howard, engineer maintenance of way of the Chicago & Eastern Illinois, with office at Chicago, has resigned. L. C. Hartley, signal engineer, succeeds Mr. Howard.

P. A. Rainey has been appointed assistant supervisor of signals on the Eastern Pennsylvania division of the Pennsylvania Railroad, with office at Harrisburg, Pa., succeeding F. J. Bauman.

# The Signal Department

## Railway Signal Standards, No. 7. The Delaware, Lackawanna & Western —Continued

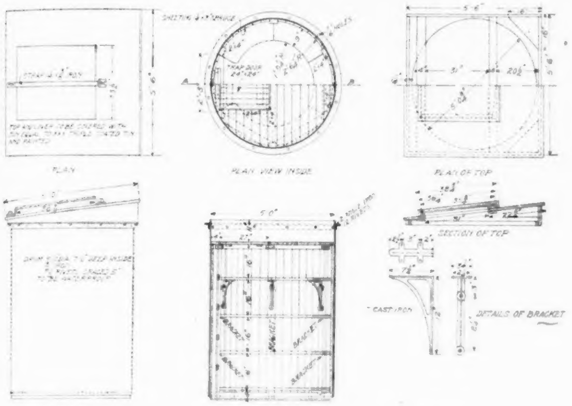
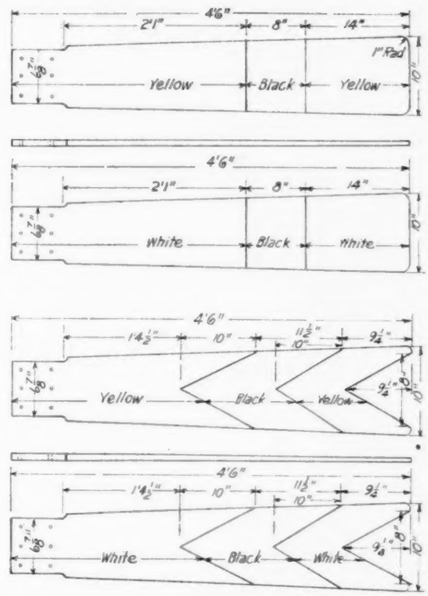


Fig. 145. Iron Battery Well.—Lackawanna.



Figs. 139-140. Home and Distant Blades.—Lackawanna.

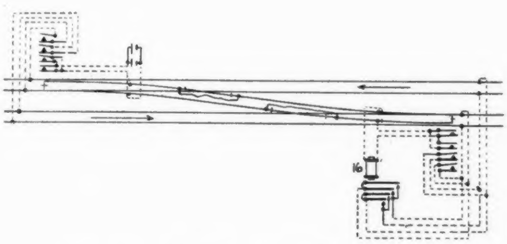


Fig. 157. Crossover Circuit.—Lackawanna.

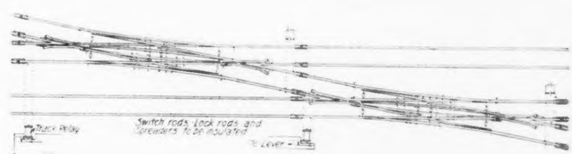


Fig. 158. Track Circuits Through Slip Switches—Lackawanna.

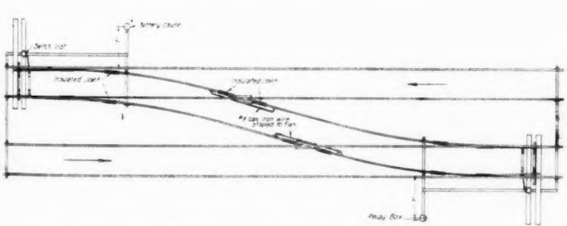


Fig. 159. Fouling Circuits for Crossover.—Lackawanna.

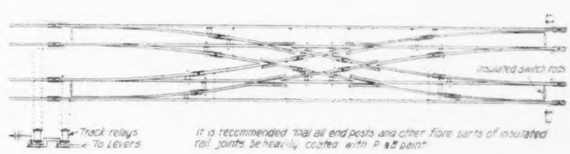
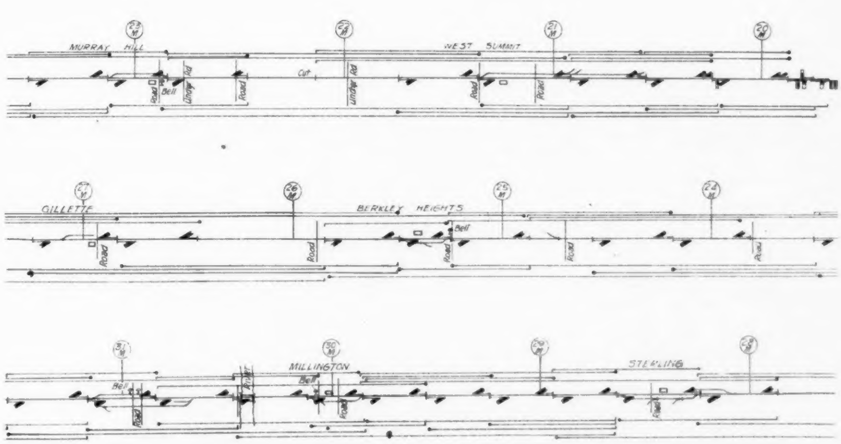
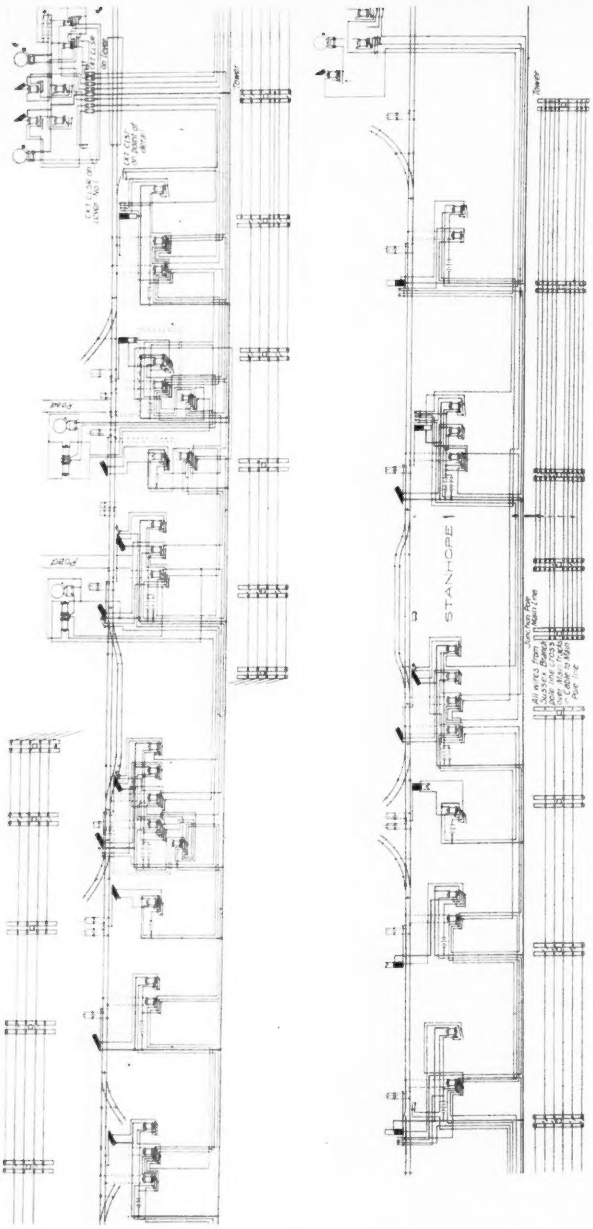


Fig. 160. Track Circuits Through Scissors.—Lackawanna.



Figs. 166-167-168. Typical Layout of Block Signals on Single Track. —Lackawanna.




Figs. 171-172. Typical Single Track Automatic Block Signal Circuits.—Lackawanna.

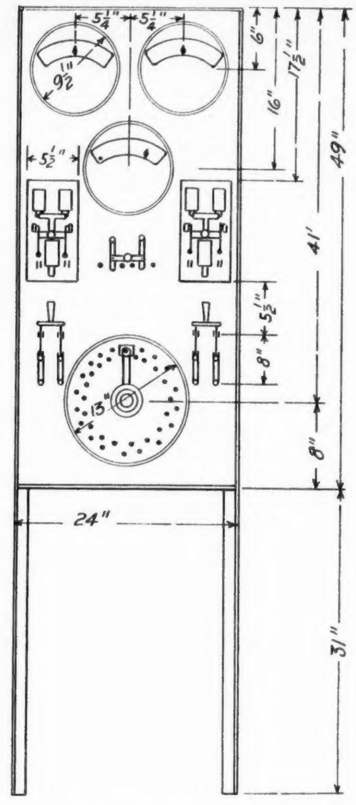



Fig. 147. Power House Switch Board.—Lackawanna.

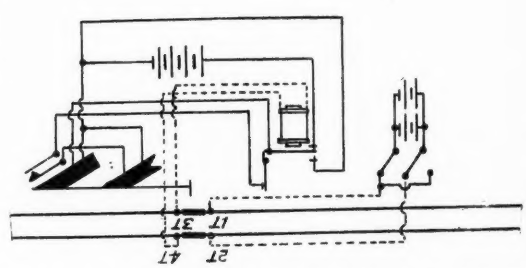


Fig. 142. Circuits for Automatic Block Signal.—Lackawanna.

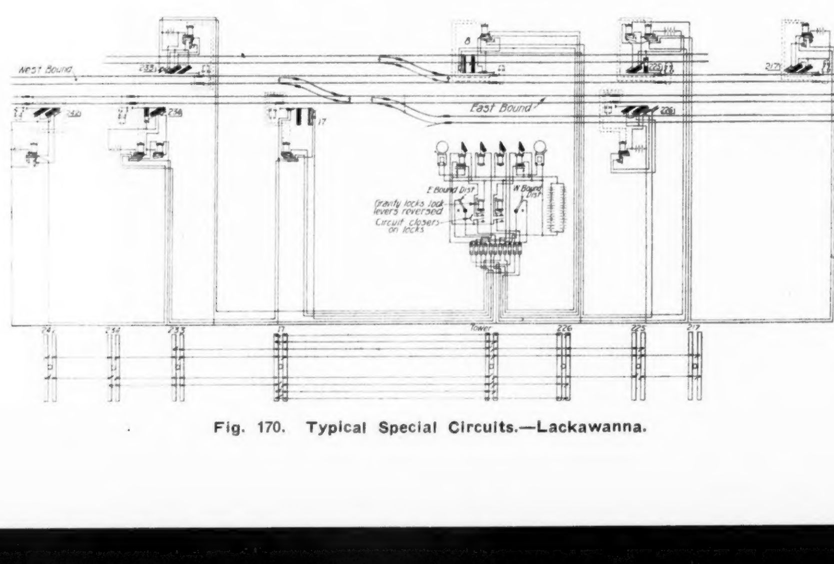
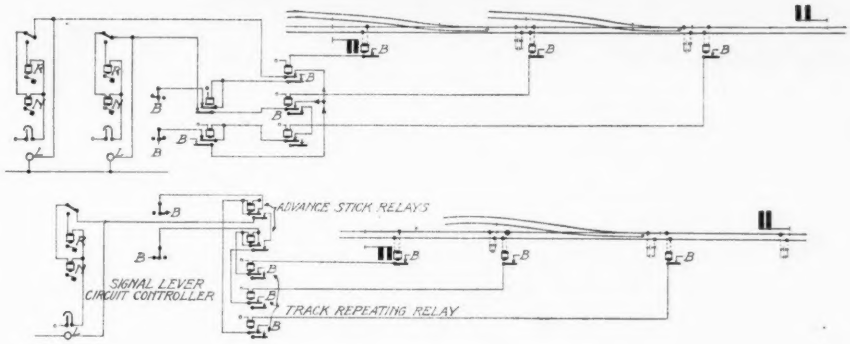
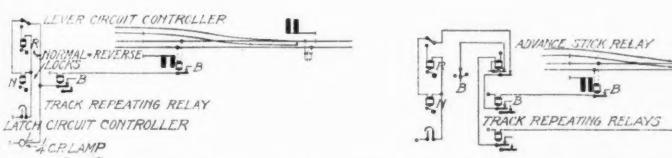



Fig. 170. Typical Special Circuits.—Lackawanna.




Figs. 173, 174, 175, 176. Route Locking Circuits—Lackawanna.

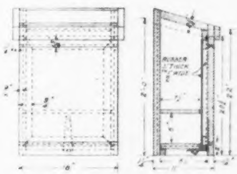


Fig. 162. Wooden Relay Box—Lackawanna.

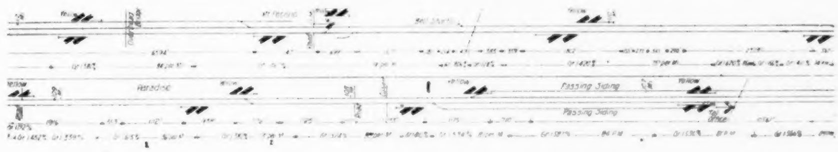


Fig. 165. Typical Layout of Block Signals on Double Track—Lackawanna.

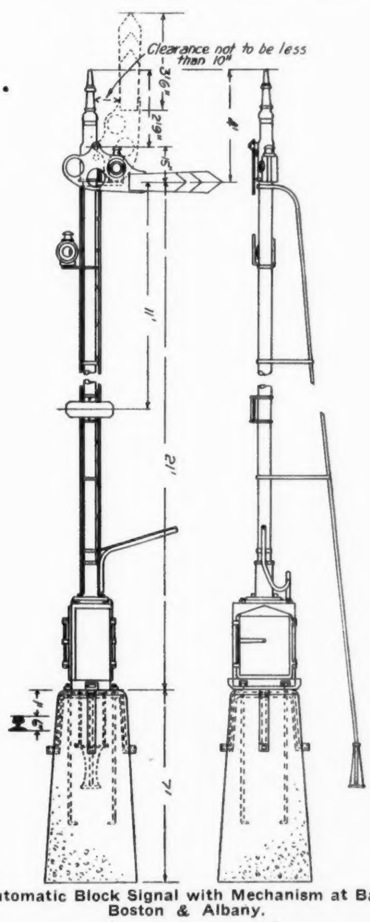



Fig. 180. Automatic Block Signal with Mechanism at Base of Post—Boston & Albany.

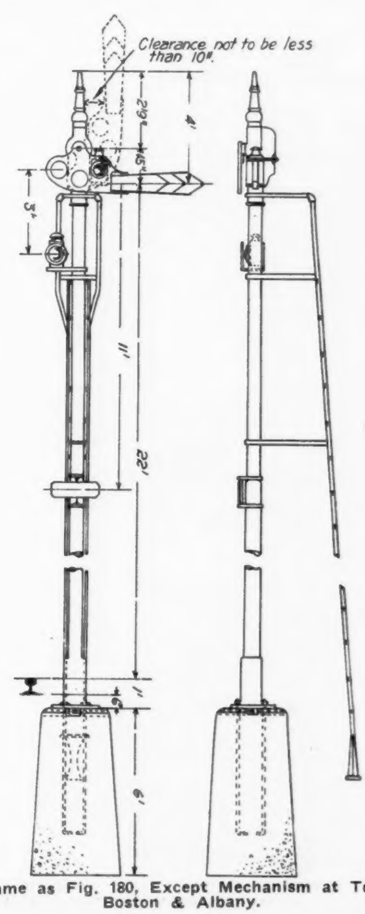



Fig. 181. Same as Fig. 180, Except Mechanism at Top of Post—Boston & Albany.

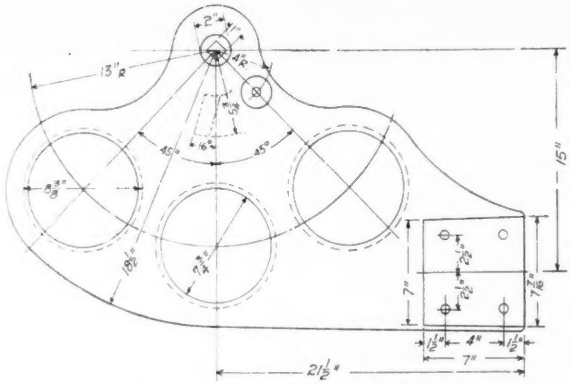



Fig. 179. Spectacle.—Boston & Albany.

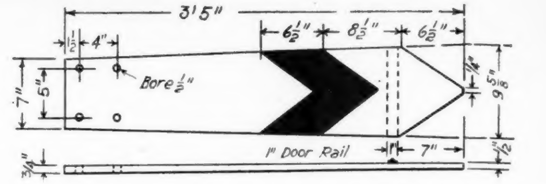



Fig. 182. Signal Blade.—Boston & Albany.

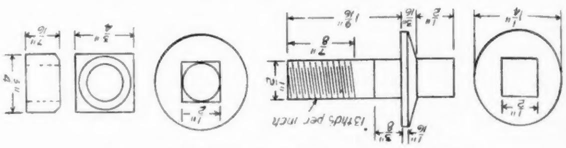



Fig. 183. Blade Bolt.—Boston & Albany.

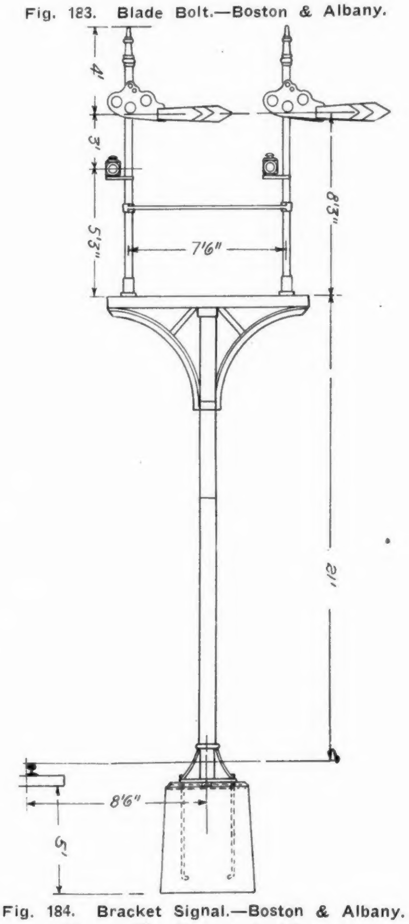
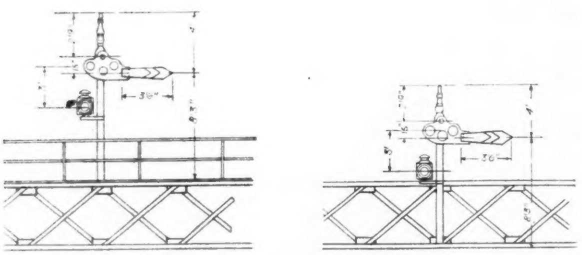



Fig. 184. Bracket Signal.—Boston & Albany.



Figs. 185-186. Signals on Bridges.—Boston & Albany.

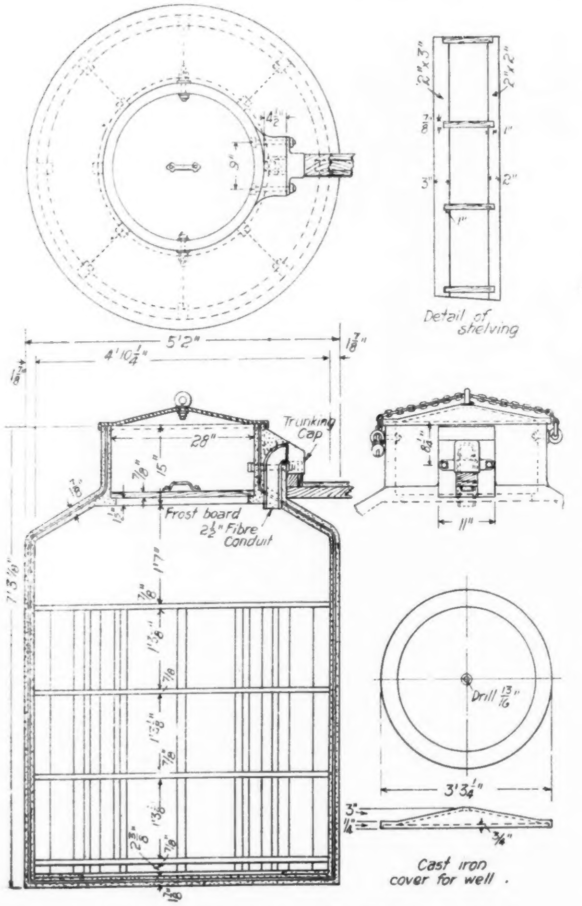



Fig. 187. Concrete Battery Well.—Boston & Albany.

## No. 8—The Boston & Albany.

The Boston & Albany has in service automatic block signals of various types, but is now installing chiefly electric-motor signals, normal danger three position, with mechanisms both at top and bottom of post. Fig. 179 shows the spectacle which is very similar to that used by the Rock Island and Lake Shore. Fig. 180 represents a complete ground signal with bottom post mechanism, while Fig. 181 shows the same for top post. It will be observed that a marker light, staggered below the working arm, is used in accordance with the scheme recommended by Committee No. 1 of the R. S. A. This light is red. At present the night color indications are white for clear, green for caution and red for stop. This will shortly be changed to green for clear, yellow for caution and red for stop. The blade is shown in Fig. 182, and the blade bolt in Fig. 183. Fig. 184 is a standard bracket signal and Figs. 185, 186 show two slightly varying situations of signals on bridges.

(To Be Continued.)

# The Maintenance of Way Department

## NEW TRACK.

Editor, Railway Engineering.

We have 32 miles of double track to build this summer with 90-lb. 33-ft. rail, broken joints. We are using Weber joints. When we lay the rail we tighten up the nut until there is at least four threads outside. By tightening them in this manner we avoid the loose bolts after the track has been put in service. We use twenty ties to a 33-ft. rail, all oak ties, fully tie-plated with four hole tie plates spiked with three spikes, two on the outside and one on the inside. These tie plates have a shoulder on them making it a solid piece of track after it is put in service. After the track is put in service the foreman that raises it the last lift puts about four men ahead of the surfacing gang, who drive the spikes down tight on the rail. This gives the men that are tamping a solid tie to tamp, one that is not so easily shoved around and out of place with the tamping pick.

Illinois. Roadmaster.

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Editor Railway Engineering:

About all the construction of new lines on this road has been done by contractors. One contractor used a track-laying machine, the others used the old method—that is, the ties would be taken to the end of the track, on a tie train, and unloaded there, and then be distributed along the road-bed with teams at night. The rails would be unloaded from the steel train in small piles and distributed with track-laying cars hauled by horses.

Maine. Roadmaster.

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Editor Railway Engineering:

The laying of track is generally done by contract, and on the last job they used a track-laying machine. They kept the steel on cars ahead of engine. The rails were canted out of cars on to trams, which ran the length of the steel cars on left-hand side. These trams had rollers, which were operated by a small engine on the pioneer car, which got its steam from the locomotive that was pushing the tram on the right-hand side. There was also a line of trams the full length of the train. These trams were also operated by the engine and carried the ties to the front, ten men laying them down as the ties dropped out; angle bars and bolts were carried on front of pioneer car. Spikes and tie plates were put in motion. Bridle rods were used to carry the train over and spiking was all done in the rear of tram.

Canada. Roadmaster.

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Editor, RAILWAY ENGINEERING:

We have little or no construction work going on and the only rail laying I handle here is the relaying of main line. We have from time to time rail which has to be taken up. This I handle with the usual steam derrick, using four men to do the necessary handling, unloading an average of 550 rails per day. If not layed out by trains too badly as to the distributing of ties, I pick up a crew and load and unload ties for distribution very often with section men, gathering them together for that purpose. Mostly all of our construction work is handled by contract. I have now about 10 miles of new rails to be laid as quick as it is received, and a considerable lot to relay which I will remove from tangents, when I will relay with a different pattern of rails. Call on me when I can be of use to your journal.

Supervisor.

Virginia.

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Editor, Railway Engineering:

Where track is to be laid without a machine, or by hand, the rail is loaded on flat cars containing from eighty to one hundred rails: much depends on the weight of rail to be laid. The foreman laying the track takes with him from two to four cars of rail and from four to eight cars of ties, which will lay from one-half to one mile of track. He usually takes enough rail and ties to last him one half day unless there is a siding near, where he can shift his train without much delay. The ties are loaded on cars containing about three hundred and twenty-five ties, which will lay one-fourth mile of track, eight ties to a rail, which is sufficient for the construction train to pass over, the remainder of the ties to complete the work are unloaded from behind the construction train by another crew.

The foreman in charge of track laying gives the instructions to the train crew, just how the ties and rail are to be placed in the train. The ties are always in front of the rail, where truck cars are to be used for handling the ties and rail to the front. After moving the train and men to the place where the track is to be laid, the foreman unloads from six to ten rails, and from twenty-five to forty ties, then the rail is loaded on a truck, and two ties are laid parallel to the rail in such a manner that the rails can be drawn out from under the ties, then the ties are loaded on top and the truck is moved to the front and the actual tack laying begins. Then more ties and rail can be unloaded from the train, and a new truck loaded while part of the force is laying the first truck load and the second truck moved to the front to take the place of the empty truck which is sent back and reloaded just in the same manner as the first; there can be a number of trucks used for track laying, but the number depends on the size of the force used.

All trucks, or track laying cars have to be fitted with rollers on the corners, on which the rails can be run out and dropped on the ties in front of the truck. The number of men used in laying track is from sixty to one hundred, and can lay from one to two miles per day.

If the ties are shipped to the track laying force loaded in box cars it is not necessary to transfer them where there is no machine used, they can be unloaded the same way as the flat cars, but it takes more men to get the same quantity out of the box cars. Where teams can be hired at a reasonable price, and the grade is sufficient to permit the ties to be dragged by the side of the track they can be placed behind the rail and the rail laid off the flat cars by using a dolley spiked on the end of the flat car, and a dolley made to be placed in the middle of the track which is set on a frame about thirty inches high. The rails are taken off the flat cars over the end, and laid, using tie rods in place of spiking the track in front of the train. One horse can drag two ties with a pair of drag hooks on a smooth grade, and twelve horses should be able to keep the ties ahead for at least two miles of track per day. If the grade is rough and narrow they will not be able to do it. With this arrangement, if sufficient dolleys are used, the rail can be passed from one flat to the other and taken down from the end of the train and laid without the use of a truck car, and will save much hard labor in handling the rail. In many cases the rail can be laid off the flats that bring it from the mills without any expense of handling before laying in the track.

In some of the timbered sections where the ties can be delivered on the new grade from the tie maker, they can be distributed on the grade by wagons and teams. It has been found that teams can deliver ties for a distance of one and one-half miles in each direction from the tie yards, and keep the cost below what it would be if the ties were loaded on a train, and delivered to the front in the usual way. The foreman, in charge of the track laying should know just how many ties he can deliver ahead of the track laying, and at what points they are distributed and provide for filling any gaps that the teams could not fill.

Where machines are to be used each kind, or make, has a different way of loading the ties and rail, and it would require too much space to fully describe the methods in detail.

Roadmaster.

North Carolina.

## Standard Specifications for Concrete Reinforcement Bars

### Adopted 1910 by the Association of American Steel Manufacturers.

The Association of American Steel Manufacturers, a technical body composed of the principal steel manufacturers of the United States, has just announced the formal adoption by letter-ballot of a standard specification governing the chemical and physical properties of concrete reinforcement bars. This announcement is an important one, since it is the first specification to appear which could be called authoritative; it also differs from the many specifications under which steel for reinforcement has been manufactured up to this time in that hard steel as well as the usual medium grade is included, in both plain and deformed sections; also in providing standards for the manufacture of cold-twisted bars. A feature of the promulgation of the new specification is the fact that this association was the first of the technical societies to formulate a specification for structural steel—the well-known Manufacturers' Standard—just as it is now the first to cover this newer field.

The need for a standard specification for these forms of construction materials, of which an enormous tonnage is used, has grown very apparent to both engineers and manufacturers, so that there is reason to expect that the Manufacturers' Standard specifications for concrete reinforcement bars will be very generally employed.

The specifications are printed below. Copies of the pamphlet will be furnished free on application to the secretary, Jesse J. Shuman, care Jones & Laughlin Steel Co., Pittsburg, Pa.

| Properties Considered | Structural Steel Grade Plain Bars | Structural Steel Grade Deformed Bars | Hard Grade Plain Bars | Hard Grade Deformed Bars | Cold Twisted Bars |
|---|---|---|---|---|---|
| Phosphorus, maximum, | | | | | |
| Bessemer | .10 | .10 | .10 | .10 | .10 |
| Open-hearth | .06 | .06 | .06 | .06 | .06 |
| Ultimate tensile strength, lbs. per sq. in. | 55/70,000 | 55/70,000 | 80,000 min. | 80,000 min. | Recorded only |
| Yield point, minimum, lbs. per sq. in. | 33,000 | 33,000 | 50,000 | 50,000 | 55,000 |
| Elongation, per cent in 8", minimum | 1,400,000 / T. S. | 1,250,000 / T. S. | 1,200,000 / T. S. | 1,000,000 / T. S. | 5% |
| Cold bend without fracture: | | | | | |
| Bars under ¾" in diam. or thickness | 180°d.=1t. | 180°d.=1t. | 180°d.=3t. | 180°d.=4t. | 180°d.=2t. |
| Bars ¾" in. diam. or thickness and over | 180°d.=1t. | 180°d.=2t. | 90°d.=3t. | 90°d.=4t. | 180°d.=3t. |

The hard grade will be used only when specified.

1. Steel may be made by either the open-hearth or Bessemer process. Bars shall be rolled from billets.

#### Chemical and Physical Properties.

2. The chemical and physical properties shall conform to the following limits:

#### Chemical Determinations.

3. In order to determine if the material conforms to the chemical limitations prescribed in paragraph 2 herein, analysis shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt or blow of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector.

#### Yield Point.

4. For the purposes of these specifications, the yield point shall be determined by careful observation of the drop of the beam of the testing machine, or by other equally accurate method.

#### Form of Specimens.

5. (a) Tensile and bending test specimens may be cut from the bars as rolled, but tensile and bending test specimens of deformed bars may be planed or turned for a length of at least 9 inches if deemed necessary by the manufacturer in order to obtain uniform cross-section.

(b) Tensile and bending test specimens of cold-twisted bars shall be cut from the bars after twisting, and shall be tested in full size without further treatment, unless otherwise specified as in (c), in which case the conditions therein stipulated shall govern.

(c) If it is desired that the testing and acceptance for cold-twisted bars be made upon the hot rolled bars before being twisted, the hot rolled bars shall meet the requirements of the structural steel grade for plain bars shown in this specification.

#### Number of Tests.

6. At least one tensile and one bending test shall be made from each melt of open-hearth steel rolled, and from each blow or lot of ten tons of Bessemer steel rolled. In case bars differing ⅜ inch and more in diameter or thickness are rolled from one melt or blow, a test shall be made from the thickest and thinnest material rolled. Should either of these test specimens develop flaws, or should the tensile test specimen break outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor. In case a tensile test specimen does not meet the specifications, an additional test may be made.

(d) The bending test may be made by pressure or by light blows.

#### Modifications in Elongation for Thin and Thick Material.

7. For bars less than 7/16 inch and more than ¾ inch nominal diameter or thickness, the following modifications shall be made in the requirements for elongation:

(e) For each increase of ⅛ inch in diameter or thickness above ¾ inch, a deduction of 1 shall be made from the specified percentage of elongation.

(f) For each decrease of 1/16 inch in diameter or thickness below 7/16 inch, a deduction of 1 shall be made from the specified percentage of elongation.

(g) The above modifications in elongation shall not apply to cold-twisted bars.

#### Number of Twists.

8. Cold-twisted bars shall be twisted cold with one complete twist in a length equal to not more than 12 times the thickness of the bar.

#### Finish.

9. Material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

**Variation in Weight.**

10. Bars for reinforcement are subject to rejection if the actual weight of any lot varies more than 5 per cent over or under the theoretical weight of that lot.

## The Railway Signal Association

The June meeting of the Railway Signal Association was held in New York City, June 14, President H. S. Balliet in the chair. About 250 members were present. The first business taken up was a discussion of the progress report of the sub-committee on standards of committee No. 1. No particular points of interest were brought out in connection with the specifications for pipe except that it was thought advisable to include a specification for galvanizing. The specifications were approved and referred to the annual meeting. In connection with the drawings, it was suggested by Mr. Kelloway that a good deal of weight might be saved by making the bracket signal base of cast steel, but the meeting approved it as drawn. The drawings of pinnacles, as well as those of the ladder foundation, concrete pipe carrier pier and lamp equipment, were recommended for adoption at the annual meeting. The drawing of binding post nut and washer was approved with the exception that it was recommended the washer be made 9-16 in. x 1-16 in. with the edges rounded so as not to cut wires. This was a compromise with Mr. Waldron, who wanted cupped washers. It was thought that should the latter be used there might be liability of workmen so placing them as to clamp a wire between two cutting edges. The drawing of the lamp was approved, except that the committee was instructed to show the door on the side opposite the lens so as to render it equally accessible with the lamp on either side of a signal post. A lamp was exhibited, showing a lens in the door in addition to the lens in the front. This latter lens was adjustable so as to be able to focus the lamp when used on a double train order signal situated on a curve.

The first part of the afternoon session was taken up with statements as to work done by the chairmen of all committees. The committee on arrangements announced that it had been unsuccessful in securing any sort of acceptable accommodations at Atlantic City and recommended that the annual meeting be held in Richmond, Va. This suggestion was approved and the matter will be submitted to letter ballot.

The secretary read a memorial to the late Henry Johnson, which was ordered sent to Mrs. Johnson.

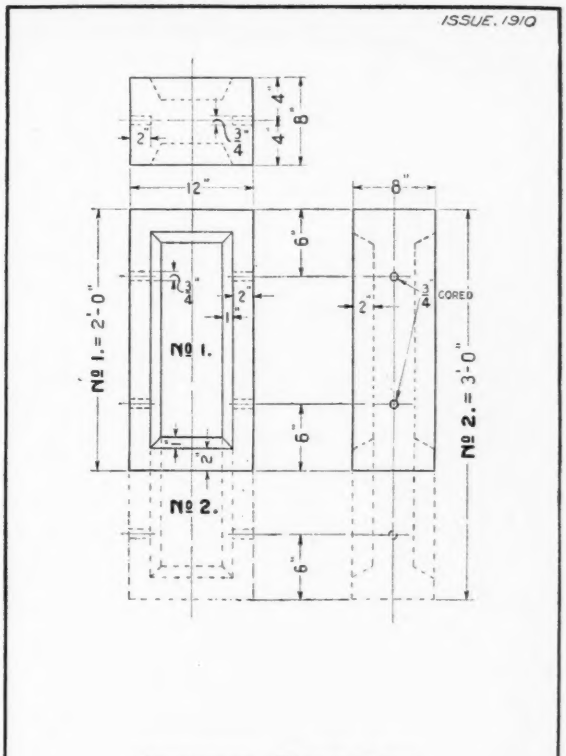
J. H. Wisner, Jr., read a paper describing the World Signal, illustrating with lantern slides. There was no discussion. A vote of thanks was extended to Mr. Wisner. This paper is reprinted elsewhere in this issue.

Mr. Waldron, of the Interborough Rapid Transit Co., followed with a paper on speed control signals, which will be found in another column. As before there was no discussion, and a vote of thanks was extended.

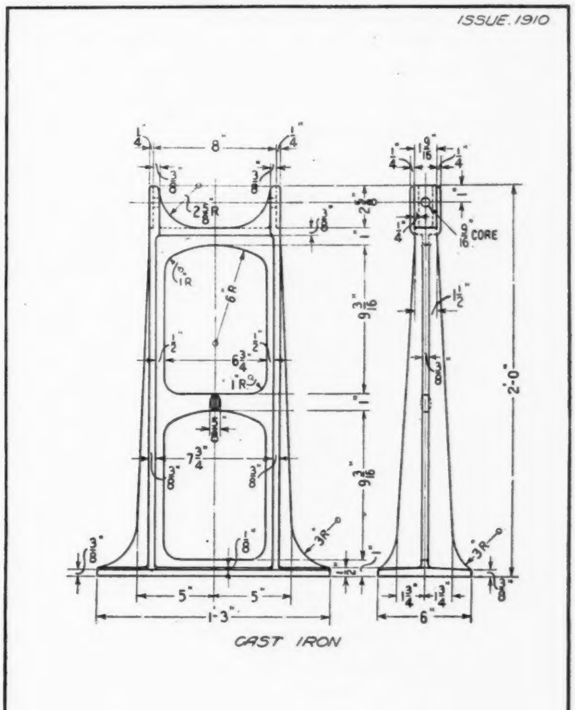
The president then called upon W. T. Wreaks, of the Wire Inspection Bureau, for a few remarks on wire inspection. He spoke for ten minutes, emphasizing the importance of thoroughness in inspection and of comparison of results as between different users and makers.

Then followed a brief discussion of the paper on alternating current power transmission by Messrs. Rhea and Kimball, which was presented at the March meeting, but nothing new was brought out.

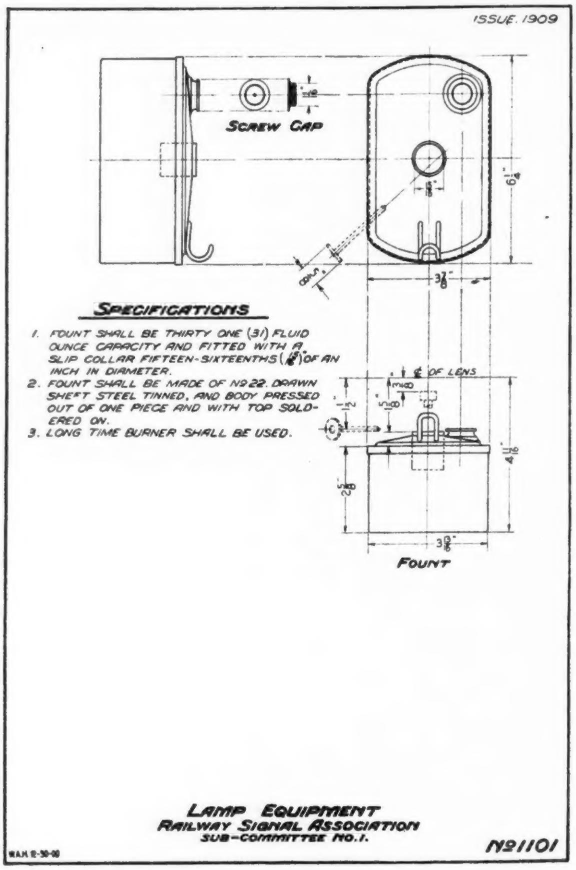
The afternoon session ended with a very brief and perfunctory discussion of the progress report of committee No. 4 on automatic block signals. The chief result being a request for further collaboration by the committee with the manufacturers.

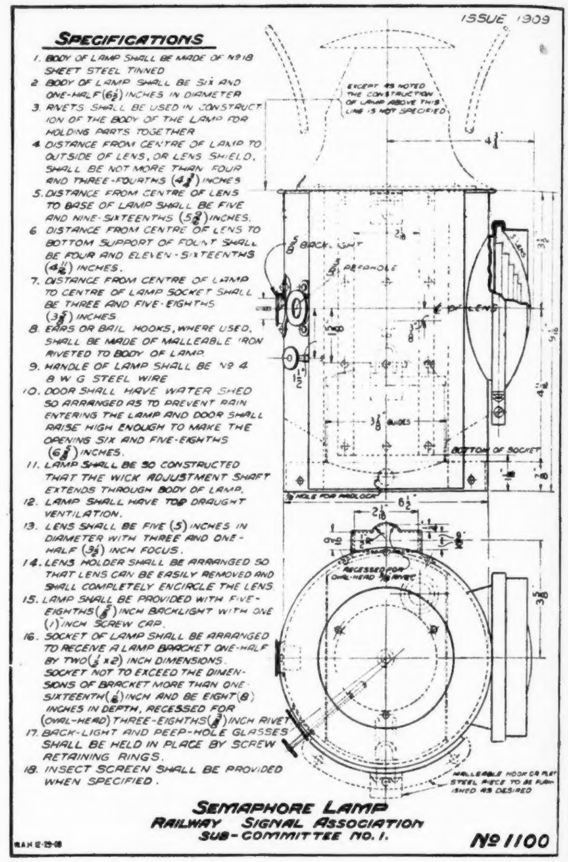


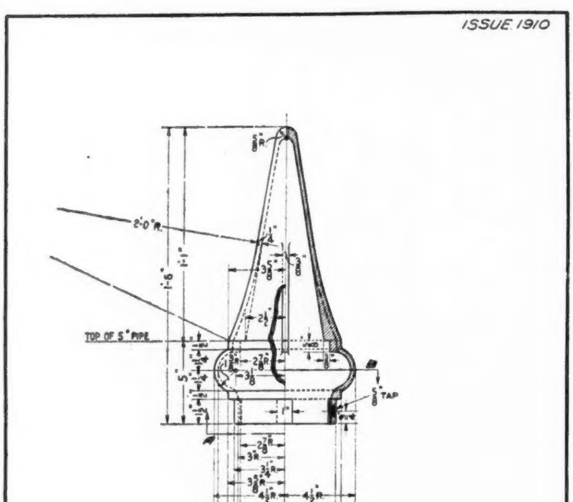

CONCRETE FOUNDATION
PIPE CARRIER
R. S. A.
Sub-Com. No. 1.
No 1080

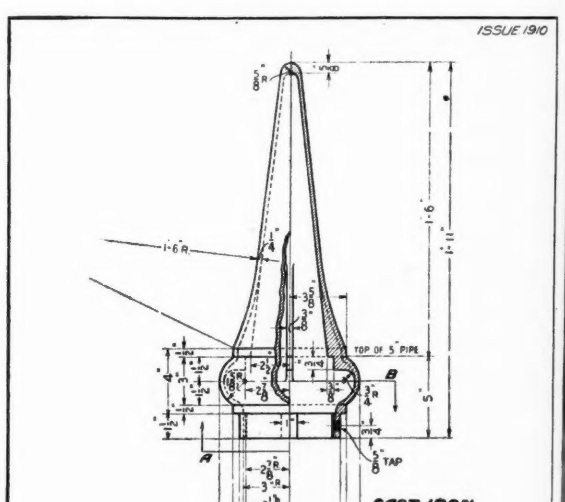


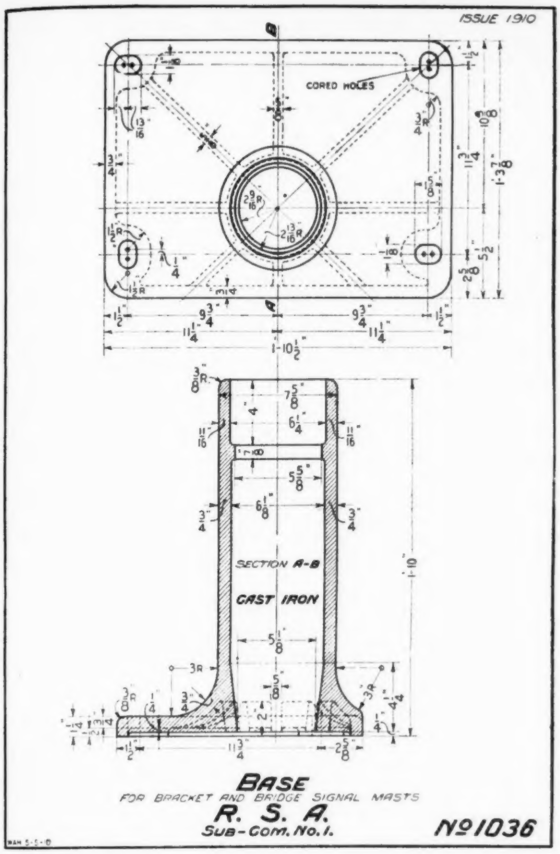

LADDER FOUNDATION
R. S. A.
Sub-Com. No. 1.
No 1052

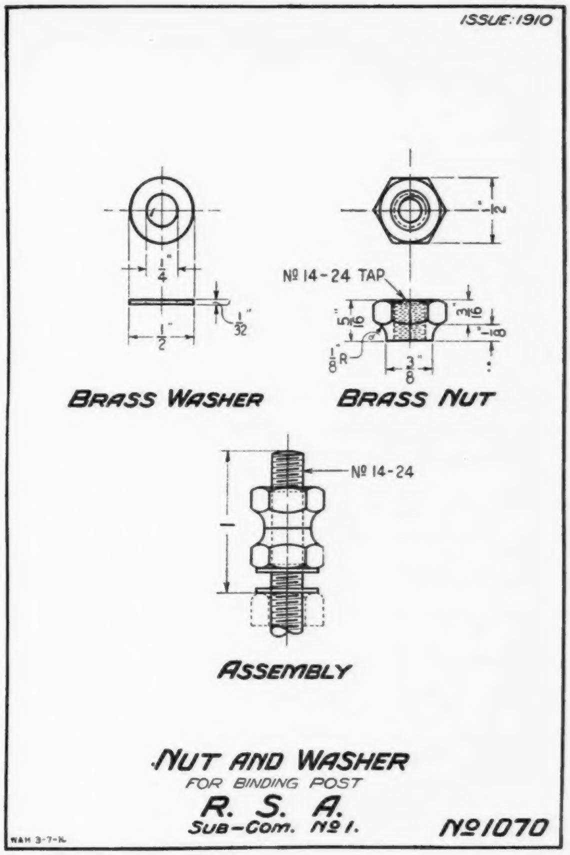

ISSUE. 1909
SCREW CAP
SPECIFICATIONS
1. FOUNT SHALL BE THIRTY ONE (31) FLUID OUNCE CAPACITY AND FITTED WITH A SLIP COLLAR FIFTEEN-SIXTEENTHS (15/16") OF AN INCH IN DIAMETER.
2. FOUNT SHALL BE MADE OF Nº 22. DRAWN SHEET STEEL TINNED, AND BODY PRESSED OUT OF ONE PIECE AND WITH TOP SOLDERED ON.
3. LONG TIME BURNER SHALL BE USED.
℄ OF LENS
FOUNT
LAMP EQUIPMENT
RAILWAY SIGNAL ASSOCIATION
SUB-COMMITTEE NO. 1.
Nº 1101


ISSUE 1909
SPECIFICATIONS
1. BODY OF LAMP SHALL BE MADE OF Nº 18 SHEET STEEL TINNED
2. BODY OF LAMP SHALL BE SIX AND ONE-HALF (6½) INCHES IN DIAMETER
3. RIVETS SHALL BE USED IN CONSTRUCTION OF THE BODY OF THE LAMP FOR HOLDING PARTS TOGETHER
4. DISTANCE FROM CENTRE OF LAMP TO OUTSIDE OF LENS, OR LENS SHIELD, SHALL BE NOT MORE THAN FOUR AND THREE-FOURTHS (4¾) INCHES
5. DISTANCE FROM CENTRE OF LENS TO BASE OF LAMP SHALL BE FIVE AND NINE-SIXTEENTHS (5 9/16) INCHES.
6. DISTANCE FROM CENTRE OF LENS TO BOTTOM SUPPORT OF FOUNT SHALL BE FOUR AND ELEVEN-SIXTEENTHS (4 11/16) INCHES.
7. DISTANCE FROM CENTRE OF LAMP TO CENTRE OF LAMP SOCKET SHALL BE THREE AND FIVE-EIGHTHS (3⅝) INCHES.
8. EARS OR BAIL HOOKS, WHERE USED, SHALL BE MADE OF MALLEABLE IRON RIVETED TO BODY OF LAMP.
9. HANDLE OF LAMP SHALL BE Nº 4 B W G STEEL WIRE
10. DOOR SHALL HAVE WATER SHED SO ARRANGED AS TO PREVENT RAIN ENTERING THE LAMP AND DOOR SHALL RAISE HIGH ENOUGH TO MAKE THE OPENING SIX AND FIVE-EIGHTHS (6⅝) INCHES.
11. LAMP SHALL BE SO CONSTRUCTED THAT THE WICK ADJUSTMENT SHAFT EXTENDS THROUGH BODY OF LAMP.
12. LAMP SHALL HAVE TOP DRAUGHT VENTILATION.
13. LENS SHALL BE FIVE (5) INCHES IN DIAMETER WITH THREE AND ONE-HALF (3½) INCH FOCUS.
14. LENS HOLDER SHALL BE ARRANGED SO THAT LENS CAN BE EASILY REMOVED AND SHALL COMPLETELY ENCIRCLE THE LENS.
15. LAMP SHALL BE PROVIDED WITH FIVE-EIGHTHS (⅝) INCH BACKLIGHT WITH ONE (1) INCH SCREW CAP.
16. SOCKET OF LAMP SHALL BE ARRANGED TO RECEIVE A LAMP BRACKET ONE-HALF BY TWO (½ x 2) INCH DIMENSIONS. SOCKET NOT TO EXCEED THE DIMENSIONS OF BRACKET MORE THAN ONE-SIXTEENTH (1/16) INCH AND BE EIGHT (8) INCHES IN DEPTH, RECESSED FOR (OVAL-HEAD) THREE-EIGHTHS (⅜) INCH RIVET.
17. BACK-LIGHT AND PEEP-HOLE GLASSES SHALL BE HELD IN PLACE BY SCREW RETAINING RINGS.
18. INSECT SCREEN SHALL BE PROVIDED WHEN SPECIFIED.
EXCEPT AS NOTED THE CONSTRUCTION OF LAMP ABOVE THIS LINE IS NOT SPECIFIED
BACKLIGHT
PEEPHOLE
BOTTOM OF SOCKET
HOLE FOR PADLOCK
RECESSED FOR OVAL-HEAD ⅜ RIVET
MALLEABLE HOOK OR FLAT STEEL PIECE TO BE FURNISHED AS DESIRED
SEMAPHORE LAMP
RAILWAY SIGNAL ASSOCIATION
SUB-COMMITTEE NO. 1.
Nº 1100


ISSUE 1910
2'-0" R.
TOP OF 5" PIPE
TAP
SECTIONAL VIEW LINE A-B
PINNACLE
CAST IRON
FOR GENERAL ELECTRIC CO & HALL SIGNAL CO'S. TOP MAST MECHANISM SIGNALS
R. S. A.
SUB-COM. NO. 1.
Nº 1051


ISSUE 1910
1'-6" R.
TOP OF 5" PIPE
TAP
CAST IRON
SECTIONAL VIEW LINE A-B
PINNACLE
R. S. A.
SUB-COM. NO. 1.
Nº 1050




## Subjects Discussed

Specifications for Direct Current Relays.

In Section No. 1, the immersion test is omitted, as investigation develops that relays water-tight in the sense that the specification intends, are rarely furnished. The manufacturers advise that relays which will withstand the immersion test are difficult to make, and even after testing, expansion and contraction due to differences in temperature, will result in the relays admitting water if again tested.

Section No. 2 omitted: "shall be satisfactory to the purchaser."

Section No. 3. Note especially the limits specified for end play in armature.

Section No. 6. As revised, this provides for a limited sliding contact. Investigation develops that the excessive sliding contact in relays is responsible for the development of considerable contact resistance. Note also that the permissible resistance, .13 ohm, applies to a relay tested immediately after assembling.

Section No. 8. This provides for a larger binding post.

Section No. 9. The insulation shall withstand a test of 3,000 volts, A. C., applied for at least two seconds, the idea being to give a momentary test rather than a prolonged test, which weakens the dielectric strength of the materials to a point where the insulation is more apt to break down than if the relay had not been given such a test.

Section No. 10, and following sections. Note particularly that these are new, and it is the desire of the committee that each member have the results checked if possible, and come to the meeting prepared to discuss the method of calibration.

Specifications for Hard Fibre.

A considerable revision in these specifications is shown and attention is particularly called to that part of it referring to acids or salts which will tend to injure the insulation properties of the material. The committee should like suggestions in reference to replacing the 1,000,000 ohms per cubic inch resistance test with the dielectric test. Calendaring is not permitted, as it tends to destroy the structure of the fibre. There is a greater variation permitted for the thickness; the tensile strength has been reduced. Criticisms of the kind and method of tests is particularly solicited.

Specifications for Tinned Channel Pins.

While the committee presents this specification for tinned channel pins only, we realize there may be some demand for coppered pins, and expressions of opinion as to this are desired. In preparing this specification, the committee has hoped to provide for a first-class pin, particular attention being given to the size of pin, malleability and test for tinning which will obviate any possibility of rusting in usual service.

Specifications for Trunking and Cover.

Owing to the difficulty experienced by some of the members in procuring suitable lumber for trunking, this specification has been prepared with a view that the very best possible material for the purpose shall be provided, and it is hoped that sufficient variety of timbers is covered in the specification to meet the requirements of the association.

A. G. Shaver,
Chairman Committee No. 4.

PROPOSED SPECIFICATIONS FOR DIRECT CURRENT RELAYS.

Amending Existing Specifications, Page 248, Vol. III, Railway Signal Association, Proceedings, 1906.

1. All relays shall be of the enclosed type with all working parts enclosed in a transparent dust-proof case.

2. Material and Workmanship.—Magnet cores and armatures shall be made of the best quality of soft annealed iron, and all other materials used in the construction of relays as well as the workmanship and finish shall be of good quality, free from defects.

3. Armature Supports.—Armature supports shall be securely mounted on the magnet cores, or the armature supports and cores may be mounted on the same piece of metal, in such a manner that the same relative position of armature and core faces will always be maintained.

Trunion of armature bearings shall be hard-drawn phosphor bronze or German silver, working in brass, bronze or German silver supports, shall be cylindrical and not less than one-sixteenth ($\frac{1}{16}$) inch in diameter.

Trunnion screws or pins shall fit tightly in their supports and be suitably secured. They shall be constructed so that they can exert no pressure on the armature bearings through improper adjustment. The end play of armature in bearings shall not be less than .010 in. and not more than .025 in.

4. Armature.—Adjustable stops or other means of adjusting armature vertically will not be permitted.

A minimum air gap of one-sixty-fourth ($\frac{1}{64}$) inch between armature and magnet cores shall be insured by hard bronze stop pins.

Stop pins must be threaded or set firmly to the bottom of the holes drilled for their reception and secured by cupping.

Single nuts used to hold moving parts shall be securely locked.

5. Contact Springs.—Contact springs or fingers shall be mounted rigidly on the armature not less than three-eights ($\frac{3}{8}$) inch from the nearest face of the same, and shall be sufficiently heavy to retain their proper adjustment after installation of relay.

6. Contact Points.—All contacts shall make a slight movement after engagement.

Front contact points of relays shall be of materials that are non-corrosive and will not fuse together, and where metal to metal contacts are used, they shall be of non-corrosive metal having a fusing point not less than that of platinum, or they may be chemically pure silver.

In assembling, all contacts must be tested and none shall show a resistance greater than 0.13 ohms.

All front contacts shall have a minimum opening of one-sixteenth ($\frac{1}{16}$) inch, and shall be made so that this opening can not be changed after installation without breaking the seal of the relay.

7. Magnet Coils.—All magnet coils shall be convenient of application to core; all insulation shall be applied before coils are assembled on cores and when assembled they must be securely held to prevent vibration.

The wire for magnet coils shall be soft-drawn copper, covered with good quality of silk or cotton, impregnated by the Vacuum Process, or with equally good insulation.

The connecting terminals of magnet coils shall be jointed by substantial binding posts provided with check nuts.

Terminal wires of magnet coils shall be not smaller than number twenty (20) B. & S. gauge.

Magnet coils shall be encased to prevent mechanical injury to wire.

8. Binding Posts.—Binding posts shall be of brass, of such construction that they will not turn in the base or frame on which they are carried. The binding posts screws for fastening wires shall be No. 14 with twenty-four (24) threads per inch. All binding posts shall have at least two washers and two nuts.

Binding nuts and washers for fastening outside wires shall be in accordance with Railway Signal Association Drawing........

9. Insulation.—An air gap of not less than three-eighths ($\frac{3}{8}$) inch, or approved insulation equivalent thereto, shall be provided between any part of the relay carrying current and any other metal part thereof. This insulation shall withstand a test with an alternating current of three thousand (3,000) volts applied for at least two seconds.

10. Calibration.—Before testing the relay cores shall be neutralized by the following method. The relay coils shall be subjected to a current three times the amount specified for pick-up in Section 11. This current shall be gradually reduced to zero with frequent reversal. Current shall then be applied to the instrument until the armature attracts, then reduced to zero and applied in reverse direction until the armature is again attracted. If these two points of attraction are the same the cores are neutral and this value of current shall be called the neutral pick-up current of the relay.

After the neutral pick-up point is determined, current of three times the neutral pick-up shall be applied and reduced until the armature falls away. This value of the current shall be called the drop-away. The circuit shall then be broken.

Current shall then be applied in the same direction and gradually increased until the armature attracts. This value of the current shall be called the direct pick-up.

Current shall then be reversed and gradually increased until the armature again attracts. This value of the current shall be called the reverse pick-up.

The direct current shall not be less than 40 per cent of the direct pick-up current and the reverse pick-up current shall not exceed the direct pick-up current by more than 20 per cent, when tested in accordance with the procedure outlined in Section 10.

11. Resistance and Direct Pick-Up.—The resistance of relays shall be in accordance with the following list, which shall also govern in respect to maximum direct pick-up current.

Direct Pick-Up Current.

| Resistance | 1 to 4 points. | 6 points. |
|---|---|---|
| 4 ohms | .075 | .090 |
| 9 ohms | .050 | .060 |
| 16 ohms | .040 | .048 |
| 30 ohms | .030 | .036 |
| 50 ohms | .025 | .029 |
| 100 ohms | .018 | .021 |
| 150 ohms | .015 | .017 |
| 250 ohms | .012 | .014 |
| 500 ohms | .0085 | .010 |
| 1000 ohms | .0065 | .0075 |

12. Sealing and Marking.—All relays must be sealed with the manufacture's seal, and resistance, direct current pick-up and purchaser's order number marked plainly on the sealed portion of the relay.

13. Tests.—The purchaser is privileged to make inspections and tests at the place of manufacture if he so elects, and the manufacturer will provide such facilities as are required for that purpose.

One relay will be selected at random from each lot of fifty or fraction thereof and subjected to test for insulation, calibration and resistance.

14. Packing.—Relays must be securely and suitably packed in strong packages in such manner that breakages are not liable to occur. The packages must be of such size that they can be conveniently handled by one man. The proper side up must be indicated together with the warning: "Glass, handle with care." Each package must be plainly marked with the address of the consignee, purchaser's order, number and contents.

15. Acceptance.—If, after physical inspection of the entire shipment and in accordance with the tests, the specification is met the shipment will be accepted. If the specification is not met, the shipment will be returned to the manufacturer, who will pay all expenses for freight on the shipment.

16. Guarantee.—Each manufacturer furnishing relays under this specification will replace, free of expense to the purchaser, all instruments which are found, within a period of one year, to be defective in materials or workmanship.

The following is what the Manufacturers' Committee may propose as analternative for similar sections, paragraphs 10 and 11.

10. Calibration.—Current of four times the direct pick-up as specified in Section 11 shall be applied and reduced until the armature falls away. This value shall be called the drop-away, the circuit shall then be broken.

Current shall then be applied in the same direction and gradu-

ally increased until the armature attracts. This value of the current shall be called the direct pick-up.

Current shall then be reversed and gradually increased until the armature again attracts. This value of the current shall be called the reverse pick-up.

Current shall then be increased to four times the direct pick-up and the above processes repeated. The corresponding current values shall not vary more than 10 per cent from those first obtained.

11. The minimum drop-away current shall be not less than 40 per cent of the maximum direct pick-up current and the maximum reverse pick-up current shall not exceed the minimum direct pick-up current by more than 30 per cent when tested in accordance with the procedure outlined in Section 10.

## SPECIFICATIONS FOR HARD FIBRE.

1. Purpose.—This material is to be used as insulation in railroad track joints, switch rods, signal apparatus, etc.

2. Material.—Fibre shall be made from a good grade of paper stock containing no mineral matter, and shall have no water repelling substance applied on its surface. It shall be thoroughly seasoned and entirely free from acids or salts of any kind which will tend to injure the insulating properties of the material.

3. Design.—It shall conform to the railroad company's standard plans.

4. Workmanship.—All surfaces, where cut, must be square and free from burrs, fins and other defects. The ends of all bushings must be sawed square. End posts and all flat pieces and angles may be furnished with ends and edges either sawed or sheared. Holes in fibre pieces may be punched.

5. Calendering.—Fibre furnished under this specification must not be calendered.

6. Insulating Properties.—When subjected to a temperature of 150 degrees Fahrenheit for twenty-four (24) hours and then a temperature of 70 degrees Fahrenheit for six (6) hours in normal atmosphere, the fibre under test must show a resistance of not less than one million (1,000,000) ohms per cubic inch of fibre.

7. Physical Requirements.—All fibre furnished must meet the following requirements:

| Thickness Required. | Dry Allowed. Max. | Dry Allowed. Min. | Lbs. Per Sq. In. Tensile Strength. | Lbs. Pressure to Punch hole 1 in. in Diameter. Dry | Lbs. Pressure to Punch hole 1 in. in Diameter. Wet | Per Cent of Weight of Sample of Water Absorbed not to Exceed 3 Hrs. | 6 Hrs. | 24 Hrs. |
|---|---|---|---|---|---|---|---|---|
| 3-32" | .103 | .082 | 12000 | 4200 | 1100 | 12 | 16 | 38 |
| 4-32" | .135 | .113 | 12000 | 4800 | 1500 | 9 | 13 | 30 |
| 5-32" | .166 | .144 | 12000 | 5400 | 2000 | 8 | 11 | 25 |
| 6-32" | .197 | .170 | 12000 | 6000 | 2700 | 7 | 9 | 20 |
| 8-32" | .270 | .230 | 12000 | 7200 | 5000 | 6 | 8 | 17 |

8. Chemical Analysis.—Analysis will be made to determine presence of acids or salts which will affect the insulating properties of the fibre.

9. Tests.—Before tests are made, except as noted below, all samples shall be subjected to a temperature of 150 degrees Fahrenheit for 24 hours.

The test for shearing strength of wet material will be made after samples, dried as above at a temperature of 150 Fahrenheit for 24 hours, have been immersed in water at a temperature of 70 degrees Fahrenheit for 24 hours.

Test for tensile strength and shearing strength of dry material will be made immediately after drying.

Absorption tests will be made on a sample 2 inches square. Care will be taken that all edges are as smooth as possible and corners square.

Chemical tests will be made on sample of material as furnished before drying.

Tests will be made at destination and immediately after receipt of material.

10. Sampling.—For test one piece will be taken at random from each lot of one hundred (100) pieces or fraction thereof, and the results obtained will be taken as representing the entire shipment.

Manufacturer will include gratis for purposes of test one extra piece with each lot of one hundred (100), or fraction thereof, of parts required to be furnished.

11. Shipping.—Fibre pieces must be packed in such a manner that they will hold their shape and will be protected from the weather and mechanical injury during shipment. Each package must be plainly marked showing contents and order number under which furnished.

12. Acceptance.—If material is found to be unsatisfactory under these specifications, it will be returned to the manufacturer, who must pay all freight charges both ways.

## SPECIFICATIONS FOR TINNED CHANNEL PINS.

1. Purpose.—The material under these specifications is to be used for fastening bond wires of a diameter of .165 inch into a 9-32 inch hole in the rail.

2. Material.—They must be made of steel or iron containing not less than 15 per cent, nor more than 25 per cent of combined carbon.

3. They must conform to Railway Signal Association Drawing No. ...... and will be calibrated by the purchaser with gauges which are accurate as compared with master gauge in the purchaser's office.

4. Pins must be put up in strong canvas bags containing 1,000 pins or containing 500 pins if so specified.

5. Each bag must be plainly marked to show the number of pins contained therein; also the order number under which they are furnished.

6. Malleability.—Channel pins must be capable of being driven entirely through a hole 9-32 inch in diameter, drilled in a piece of steel plate 9-16 inch thick without showing a flaw or crack of any kind. In addition the pins after being driven through the thickness of the steel plate must stand bending 90 degrees flat on the plate without cracking or showing a fracture of any kind.

7. Tinning must be well done, even in thickness throughout, smooth and free from lumps.

8. Method of Testing.—The channel pins will be thoroughly cleaned with gasoline or varnish remover and finally with soap and water, rinsing the clean pin thoroughly with clear water. The pin is then immersed in hydrochloric acid solution for one minute and then, without wiping, dipped into the ferro-cyanide solution. If a blue precipitate or coloration takes place it indicates the tin coat has been dissolved. The pin is washed in clear water to free it from the ferro-cyanide solution and the operation repeated. Channel pins which have been tinned in a satisfactory manner should stand four immersions of one minute each, in the hydrochloric solution.

9. Solution for Tinning Test.—Potassium ferro-cyanide solution: 5 grams of the salt are dissolved in 1,000 cc of distilled water.

10. Hydro-chloric acid solution should be of specific gravity, 1.10, made by diluting hydrochloric acid, specific gravity 1.20, with its own volume of distilled water.

Note.—Instead of distilled water hydrant water may be used if, on testing with ferro-cyanide, it does not give a precipitate or coloration.

11. Gauging.—If more than 5 per cent of the samples taken from any bag fail to show the proper dimensions as shown in Railway Signal Association Drawing No. ......, or as determined by the gauge, then the whole bag shall be rejected.

12. Samples for Testing.—Twenty (20) or more samples will be taken at random from each bag of 1,000 or fraction thereof and five will be used for making the test for tinning.

13. Acceptance.—This material will be inspected and tested at the works where it is made. The manufacturer must notify purchaser at least two days before the pins will be ready for shipment and must furnish, free of cost, testing apparatus and assistance necessary to make satisfactory inspection and test.

If the purchaser prefers to test and inspect pins after they reach destination, the manufacturer will be notified by him to ship them with the understanding that if they fail to meet the requirements of these specifications they will be rejected. Pins failing to meet the above requirements will be returned to the shipper at his expense.

## SPECIFICATIONS FOR TRUNKING AND COVER.

### General.

1. The material required under these specifications is wooden trunking, to be used for the protection of rubber insulated wires in railroad signaling.

2. It must be furnished either surfaced four (4) sides or rough as specified. When furnished surfaced four (4) sides it must conform to dimensions shown on Railway Signal Association Drawing No. ...... When furnished rough sawed, the outside dimensions as shown on the drawing will be considered a minimum and a variation of not more than ¼ in. will be allowed for maximum, while for the groove the dimensions as shown on the drawing must be adhered to for the minimum and an increase in size of ⅛ either way will be allowable as maximum.

3. Trunking and cover shall be graded on finished or better side, but the other side shall not be more than one grade below.

4. Lumber shall be manufactured and shipped uniform and even in lengths approximately 16 feet long. No piece shall be less than 14 feet nor more than 18 feet long.

5. Knot holes will not be permitted.

6. Shake will not be permitted.

7. Wane shall not extend more than one-half (½) inch across any face nor more than one-quarter (¼) the length of any piece.

8. Sides of groove may be sawed but bottom must be knife cut.

9. May have one split not to exceed in length the width of the piece.

### Cypress Trunking.

10. May have one-half (½) inch bright sap on either edge.

11. May have one to three small sound knots not more than three-quarters (¾) inch in diameter if well scattered so as to not materially affect the strength of the piece.

### White and Norway Pine.

12. Bright sap will not be considered a defect. A small amount (not more than ten (10) per cent) of stained sap will be permitted.

13. Round sound knots not larger than one (1) inch in diameter and not more than six (6) well scattered in any piece will be permitted.

### Yellow Pine and Fir.

14. Bright sap will not be considered a defect. A small amount (not more than ten (10) per cent) of stained sap will be permitted.

15. Round sound knots not larger than one (1) inch in diameter and not more than six well scattered in any piece will be permitted.

16. Small pitch pockets not over four (4) inches in length will be permitted.

17. All over-shipments of any size of lumber, on any order, will be entirely at the risk of the shipper and the purchaser will not be responsible for their safe keeping.

18. No allowance whatever will be made for material rejected. Freight charges on rejected lumber will be deducted from shipper's invoice and 75 cents per thousand feet will be deducted from invoice for handling culls at destination. If shipping instructions are issued by shipper for rejected material, full freight charges will follow shipment to destination. A charge will be made for sawing material shipped in multiple lengths.

19. Inspection reports showing the result of inspection will be mailed to the shipper within two weeks after the unloading and inspection of the material, and rejected material will be held for thirty days from the date of the inspection report, free of charge, during which time the shipper is expected to give disposition to the purchaser for such rejected material. Failure on the part of the shipper to give the purchaser such disposition will be considered as authority from the shipper to charge storage after the expiration of the thirty days mentioned, at the rate of 25 cents per thousand feet per day. Such charges will be deducted from the invoice of the shipper when final settlement is made for the lumber.

## SPECIFICATIONS FOR CAUSTIC SODA PRIMARY BATTERY.

1. Purpose.—This battery is used in the operation of electric motor semaphore signals, crossing bells, etc., known as the signal cell, 400 ampere hours capacity.

2. Material.—(a) Railway Signal Association drawing, issue 1910, shows the general design and dimensions of the battery jar, cover, connecting wire and that part of the bolt supporting the elements above the top of the cover, together with nuts and washers. The active parts of the cell consist of zinc, copper oxide, caustic soda in the solid form which, mixed with water, forms the solution in which the elements are placed, and a suitable paraffine oil, which is used on top of the caustic soda solution to prevent evaporation and the salts from creeping over the top of the cell.

(b) The assembled element shall consist of the zinc and copper oxide suitably combined together with the suspension bolt and terminal wire of sufficient length to extend 11 inches above top of jar.

(c) A renewal shall consist of the assembled element, and sufficient electrolyte (caustic soda) and the paraffine oil in hermetically sealed receptacles.

(d) A complete cell shall consist of the jar, cover, assembled element, electrolyte, paraffine oil, and nuts and washers for suspension bolt.

3. Requirements.—Each complete cell or renewal shall have a capacity of at least 400 ampere hours and the drop in voltage in service within this capacity must not be sufficient to affect the efficiency of the apparatus operated.

4. Test: Upon Receipt of Shipment.—(a) In order to determine the ampere hour capacity of the cell or renewal, one will be selected at random from each lot of one hundred (100) or fraction thereof, and placed on a continuous discharge of one ampere. If the discharge continues 400 hours without the voltage falling below .5 per cell, the cell or renewal will be considered acceptable as far as capacity is concerned.

(b) One will be selected at random from each lot of one hundred (100) or fraction thereof, and subjected to a discharge of three amperes continuously. If, during the first 40 hours, the voltage does not drop below .53 and during the next 40 hours the voltage does not drop below .50, the cell or renewal will be considered acceptable so far as drop in voltage test is concerned.

5. Packing.—All complete cells and renewals must be securely packed with straw or excelsior in strong boxes or barrels in such a manner that breakages are not liable to occur.

Each package must contain either eight or sixteen cells, or renewals, and there must be plainly marked on both the outside and the inside of the package the name of the consignee, destination, contents of the package and the purchase order number.

6. Acceptance. If, after physical inspection of the shipment and in accordance with the above requirements and

test, the specifications are met, the shipment will be accepted. If the specifications are not met the test will be repeated. If the second test is satisfactory, a third test will be made. If two out of the three tests are satisfactory, the shipment will be accepted. If two of the three tests are not satisfactory, the shipment will be returned at the expense of the manufacturer, who will pay expense of freight on the shipment as well as the cost of making the second and third test.

7. Guarantee.—Each manufacturer furnishing complete cells of caustic soda battery or renewals must guarantee his goods to be free from defects, and that in case there is a failure of one or more cells in any set of sixteen more or less, due to what are obviously defects in material, design or construction, the manufacturer will replace such defective cells or renewals of the battery free of cost to the railroad company.

PROGRESS REPORT OF SUB-COMMITTEE OF COMMITTEE NO. 1.—STANDARDS.

SPECIFICATION FOR ONE-INCH SIGNAL PIPE.

(Wrought Iron.)

1. Pipe.

Pipe must be genuine wrought iron made from puddled pig iron; no scrap will be permitted except the crop ends of wrought pipe itself. Pipe must be straight, tough, fibrous and uniform in quality throughout, free from cinder pockets, blisters, burns and other injurious flaws. Pipe must be hot galvanized inside and outside, unwiped.

2. The tensile strength, limit of elasticity and ductility, and weld, shall be determined from a test piece cut from finished pipe.

3. All pipe shall have a tensile strength of not less than forty-eight thousand (48,000) pounds per square inch, and an elastic limit of not less than thirty thousand (30,000) pounds per square inch, and an elongation of not less than ten per cent (10%) in a measured length of eight inches. All pipe must stand one thousand (1000) pounds per square inch hydraulic pressure.

When so required by the purchaser, the following test shall be made:

Test for Weld.

From each one thousand (1000) feet of finished pipe, a piece six feet long shall be cut from a length selected at random, and subjected to test as follows: (1) One man cut by hand, with standard stock and die, one and one-half inches of thread; (2) Punch two (2) one-quarter inch (¼") holes on welded seam, two inches and four inches from threaded end, without use of plug or filler piece; (3) Twist piece though angle of one hundred eighty degrees (180°) by clamping one end and turning the other end. After tests, if twenty per cent (20%) of the pieces show split or fracture at weld, the lot will be rejected.

4. The weight of one foot of one-inch pipe, before galvanizing, should be 1.71 pounds, and in no case will pipe be accepted weighing less than 1.63 pounds per foot, weight of coupling not included.

5. The outside diameter of pipe must conform to Brigg's Standard. Any pipe enough less than 1.31 inches in diameter to result in flat thread will be rejected.

6. The manufacturer shall furnish all necessary facilities for making tests and the tests shall be made at the mill.

7. Inside diameter of all pipe must be large enough to receive a hardened steel plug of 63/64-inch diameter for a length of six inches.

Drawing No. 1100 shows lamp with five-inch lens. No decision has been reached by either Sub-committee or the whole committee as to size of lens and the Committee would like to have this question discussed at the meeting.

Following are the questions pertinent to the subject:

What size lens do you favor?

What size are you now using?

What would you recommend for standard for this semaphore lamp.

Similar answers in regard to switch lamps:

What size lens do you favor?

What size are you now using?

What would you recommend for standard?

Shall all four lenses be of the same size?

## Second Annual Report of the Block Signal and Train Control Board to the Inter State Commerce Commission *

The board was appointed on July 10, 1907. Its function is to investigate and report to the Commission upon the use of and the necessity for appliances and systems for the promotion of safety in railway operation, including the making of any necessary tests. Its first annual report was made November 20, 1908. As a preface to the account of the doings of the board since that date it will be proper briefly to recall the substance of that report. An informal report had been presented one year before; and still further back (Feb. 23, 1907) railroad signaling had been made the subject of a special report by the Commission. November 20, 1908, we reported having examined the plans and specifications of 371 devices, of which 184 had been reported on, and of which 12 had been considered to possess some merit. Of the 12, one was installed and ready for test, and the proprietors of four others were making preparations. The report gave information concerning the use of the manual block system on the railroads of this country and England; the controlled manual block system on double-track and single-track lines; automatic stops on the Interborough Rapid Transit Company's lines in New York City; the use of cab signals in England and in France (no cab signals being used in America); and on the use of the telephone in manual block signaling. Action of the Railway Signal Association in regard to automatic stops and cab signals was noticed.

This past year the time of the members has been taken up mostly in examining plans and drawings of inventions and, in some cases, models. As in the previous year, nearly all of the propositions laid before the board were lacking either in merit or novelty. A very large proportion of the inventors were unfamiliar with the conditions which have to be met in railroad practice, as well as with the state of the art of that department of railroad operation with which they dealt. This year, at least, much of the time of the members of the board has been taken up by interviews with inventors and proprietors of inventions; and, as will be understood from what has just been said, the amount of time and patience demanded by these interviews has usually been in inverse ratio to the value of the invention which was the subject of discussion. When the first annual report was submitted a number of proprietors of inventions had presented applications accompanied by statements that they expected to have installations of apparatus ready for inspection by the board at an early date; and on the basis of these statements this report should have contained mention of a number of installations ready for test. Still other inventors and proprietors have persistently urged the board to an early decision on the merits of their plans; but the fact is that only one installation is actually ready for test under government supervision. Some of these applications which the proprietors have no diligently followed up concern plans which were approved by the board two years ago.

*The Block Signal and Train Control Board. M. E. Cooley, Chairman; Azel Ames, F. G. Ewald, B. B. Adams; W. P. Borland, Secretary.

One mechanical trip automatic stop (the Rowell-Potter device) has been tested by the board. This was on the lines of the Chicago, Burlington & Quincy Railroad, and the tests were continued from December 4, 1908, to April 30, 1909. One other automatic stop, the overhead mechanical trip of Mr. S. H. Harrington, has been in experimental use on the Northern Railroad of New Jersey, a subsidiary of the Erie Railroad, during the past year. This apparatus was not formally brought before the board until recently, Mr. Harrington having taken the commendable course of testing his device thoroughly before asking this board to consider it. The board is preparing to test this apparatus during the coming winter.

Extended inquiry has been made into the conduct of the manual block signal stations and the telegraph offices on a considerable number of the principal railroads of the country; this with a view to gaining information as to the efficiency and character of the men employed in these departments of the railroad service. Incidentally to this inspection, information has been gathered concerning experience with telephones on those roads which have introduced telephones in the place of the Mors telegraph for the communication of train orders from the dispatcher's office to the stations along the line; and in the next statistical report of block-signal mileage on the railroads of the country it is proposed to include a statement of the mileage of road on which telephones are used for sending train orders. Information has been gathered concerning the use of the "A B C" dispatching and block system used on the Northern Pacific Railway.

Outside of the signaling and train-control field the board has investigated (*a*) the subject of locomotive ash pans, which, after January 1 next, will be subject to inspection by the Interstate Commerce Commission in accordance with the provision of the "ash-pan law," making it unlawful to use any locomotive not equipped with an ash pan which can be dumped or emptied and cleaned without the necessity of any employee going under such locomotive; (*b*) air-brake devices and numerous proposed improvements in air-brake couplings and other details; (*c*) wheels, for cars, designed to revolve independently of the axle; (*d*) various other proposed improvements in cars; (*e*) numerous designs of joints, fastenings, and other proposed improvements in rails; (*f*) metal and composite ties for track, and arrangements for fastening rails to metal ties; (*g*) the use of titanium in rails, and (*h*) miscellaneous proposals for the promotion of safety on railroads.

Taking a statistical view of the work accomplished, it appears that since the organization of the board, plans and descriptions of inventions designed to enhance the safety of railway operation have been submitted for consideration to the number of 835. At the time the board's first annual report was made 184 files had been examined and reported upon; since that time 327 files have been examined and reports thereon transmitted to the proprietors. Of the 327 files considered during the past year, 12 have dealt with inventions held by the board to be of such character and to possess such a degree of merit as to warrant the board in conducting tests of them if satisfactory installations for that purpose are offered by the proprietors. Fourteen others were considered to be conceived on right principles, but because they were not primarily designed to promote safety, or because for various reasons the public interest did not seem to require it, the board has not felt justified in devoting time to test them or to conduct further investigations in regard to them. The board has disapproved 303 devices, either as being unsound in principle or design, as not being adapted for use under present railroad operating conditions, or as not being sufficiently developed. The board has in its possession plans of approximately 227 devices which now await its attention. A number of inventors and proprietors have as yet not furnished complete plans and specifications of their devices

The board has held monthly meetings, usually at Washington. In the period from November 1, 1908, to November 1, 1909, the secretary has received approximately 2,600 letters relating to the work of the board and the several devices under examination, and during the same period 3,500 letters have been written by him. Three thousand copies of the board's first annual report, and 2,000 copies of a report containing statistics of block-signal mileage on railroads of the United States on January 1, 1909, have been distributed from the secretary's office.

The statistics of mileage of railroads in the United States worked by the block system, with supplementary tables showing kinds of apparatus and methods of operation, which were gathered by the board last January, were published in a pamphlet, as just mentioned. A similar pamphlet is being prepared to show similar statistics of the conditions on the railroads on the 1st day of January, 1910.

Not so many companies have extended the use of the block system during 1909 as during 1908; a few, however, have made large installations. On the Rock Island lines 189 miles of single-track and 54 miles of double-track road has been equipped with automatic signals since January 1, 1909, and the work on about 100 miles more is nearly or quit completed. On the lines of the Union Pacific system and the Southern Pacific Company, which already had automatic signals on over 4,000 miles, about 333 miles of line has been equipped since January 1, 1909.

### The Manual Block System.

An important part of the board's work during the past year has been the inspection of the personnel of telegraph offices and block-signal stations, and the methods of operation pursued in such offices on a number of prominent railroads. This inspection was begun because of the occurrence during the past three years of a considerable number of collisions of trains in consequence of errors or neglect on the part of telegraphers. The reports of these inspections afford a great mass of information concerning the conduct of the telegraph, telephone, and manual block-signal departments of railroads generally. Telegraph operators holding responsible positions without having received more than superficial instructions are common on a number of important roads. On one road a new book of rules was introduced without formal examination of the men on the changes. On certain large divisions of western roads the indications of inefficient supervision are confirmed by records showing that 25 per cent or more of the station offices become vacant yearly by reason of dissatisfaction on the part of the men or by their dismissal because of unsatisfactory service. On the other hand, the strictly managed roads show records of hundreds of offices with few or no appointments in a whole year. Since the date when the federal nine-hour law came into operation many offices, manned by three telegraphers, have for the "third trick" one noticeably deficient in experience or other qualifications, while the other two operators are better; though, of course, the need of having one entirely reliable is almost or quite the same throughout the twenty-four hours.

In the dispatchers' offices, the "nerve centers" of the train-running department of all busy single-track railroads, inefficient management has been found in a number of cases, and in a few the faults of practice have been such as nearly or quite to warrant the use of the term "dangerous."

The use of the telephone in train dispatching, which has been greatly extended during the past year or two, introduces some new conditions which ought to be investigated. With the telegraph nearly all of the operators have always learned to send and receive in the railway telegraph offices. This learning period, extending over many months, has given each learner a valuable opportunity to acquire a good knowledge of the office work and incidentally a good deal about train operation, by observation. With the telephone no such extended training period is necessary, and both young men and young women are taken into offices and charged with responsible duties when they have had little or none of the training that comes from con-

tact with actual work. Not many cases of this kind have been specifically named, but the indications, in connection with other things observed, clearly evidence the importance of keeping informed concerning this feature. The superintendent who is reasonably cautious takes care, of course, to intrust no person with the responsible duties of station telegrapher or block signalman until that person has been under tutelage for as long a time as may be necessary; but superintendents are not in all cases reasonably cautious. The introduction of the telephone affords an opportunity to railroads to fill these station positions with men who have been disabled in the train service; men who have much knowledge of railroad work generally, yet who could not readily learn telegraphy because of having passed the youthful age when such learning is easy. Often it is possible thus to give satisfactory employment to such disabled persons and greatly ameliorate their condition. It has been observed, however, that in some cases there has been too ready an assumption that because the disabled person is familiar with train work he is also well informed about station office work. Whatever a person's antecedents, the duties of station operator, either telegraph or telephone, require that the beginner at the work be very carefully trained.

The gist of the information thus gathered is that while in a great many of the cases observed the men in the telegraph and signal departments give evidence of character and ability, a fact which the board is glad to emphasize, there is at the same time ample evidence from the inspections that have been made and from the testimony of the official accident records, to confirm the conclusion, tentatively reached last year, that in the employment and discipline of telegraph operators and signalmen the practice on many railroads is open to grave criticism. Men lacking in experience, men with considerable experience but lacking in character or not well trained, and boys too young to have had satisfactory experience, have been found in all parts of the country. Such a situation strongly reinforces the declaration, made by the commission repeatedly, which was set forth in the report of February 23, 1907, and reiterated in that of December, 1908, that not only should the railroads of the country be required to adopt the block system, but that the Federal Government, working through competent officers, should supervise the establishment and operation of the block system everywhere, at least to the extent of seeing that adequate and suitable block-signal regulations are adopted and that proper publicity is given to all such features of this department of railroad working as are not susceptible of satisfactory government regulation, but which yet are not managed on that high plane of safety and efficiency that the public rightfully demands.

The board does not argue the case. The issue is already well understood. The accident records alone afford a mass of evidence that calls loudly for such action by the Government as shall give the public more light on the quality of the service afforded by many railroads in this particular.*

Under the act of Congress by which the Commission was guided in establishing this board the thing required was an investigation as to the use of and the necessity for the block system and consideration of appliances or systems intended to promote the safety of railway operation. Ample evidence has been found of the need of improvement. It is not deemed advisable in this report to present specific cases, with evidence formally marshaled, for to do so would involve elaborate inquiries, consuming much time, and all for no other purpose than to prove what is already reasonably proved, that inefficient telegraphers and signalmen are sufficiently common on the railroads of the country to impose on the government—representing the people—the duty of thoroughly investigating that department of railroad operation. Such investigation as has thus far been made can be looked upon only as a beginning.

| Bulletin No. | Table No. | Collision No. | |
|---|---|---|---|
| 29 | 2a | 2 | Dispatcher not sufficiently careful. |
| 29 | 2a | 6 | Failure to deliver order; inexperienced operator intrusted with responsibility. |
| 29 | 2a | 8 | Mistake in writing order; operator inexperienced. |
| 29 | 2a | 9 | Operator accepted order after train had passed; conduct irregular in several respects. |
| 30 | 2a | 5 | Operator careless in identifying trains. |
| 30 | 2a | 7 | Operator gave erroneous information to dispatcher; inexperienced. |
| 30 | 2a | 8 | Operator having two orders to deliver, delivered only one of them. |
| 30 | 2a | 22 | Operator gave erroneous information to dispatcher. |
| 31 | 2a | 1 | Dispatcher wrote wrong station name in order. |
| 31 | 2a | 3 | Dispatcher gave order to inferior train before restricting superior train. |
| 31 | 2a | 4 | Operator failed to stop train for which he held an order. |
| 31 | 2a | 7 | Operator, inexperienced, wrote wrong station in order. |
| 31 | 2a | 12 | Operator wrote wrong train number in order. |
| 31 | 2a | 14 | Operator gave clear block signal wrongfully. |
| 32 | 2a | 4 | Operator neglected to deliver order. |
| 32 | 2a | 7 | Operator failed to deliver order. |
| 32 | 2a | 10 | Operator made mistake in name of meeting point in writing dispatcher's order. |
| 32 | 2a | 12 | Error of dispatcher. |

*A B C method of operation.*—The A B C method of operating the block system, as used on the Northern Pacific, which was briefly mentioned in our last annual report, has been made the subject of further inquiry. Its use has been extended and it is now in force on over 600 miles of the lines of the company named.

A description of the system will be found in the appendix. In brief, it is a method of increasing the safety of the simple manual or telegraph block system on single-track lines by having three men (instead of two) take part in the operation for each train movement. A similar system has been in use on the Erie Railroad in Ohio for eighteen years or more; but in that case the long-standing regulations for making meeting points for trains by elaborate written orders, to be repeated back and to be signed by the conductor or the engineman, or both, are retained in full force, and the block-signal rules therefore have not been amplified, as on the Northern Pacific, with a view to providing *all* the safeguards necessary to arrange meeting points with regularity, facility, and safety.

The A B C system is designed to facilitate train movements as well as to safeguard them. It saves time mainly in the issuing of dispatchers' orders. On single-track railroads which are traversed by a considerable number of trains, but which are not well equipped with block-signal apparatus, so much time is consumed in preparing and sending of dispatchers' orders that trains are greatly delayed. While for regular passenger trains (when not behind time), the meeting points can be prescribed in the printed time-table, all irregular trains and all trains when not "on time" must continually depend for their movements on the dispatcher; and he, in consequence of the variation in the speeds of trains and of the constant necessity of making up freight trains on short notice, has to issue many telegraphic orders daily. These orders must be written out, must be repeated back over the wire to insure correctness in transmission, and must be subjected to rigid safeguards in their delivery. All this consumes much time. By the A B C system much of this time is saved. All movements are made on the order of the dispatcher, instead of partly by time-table and partly by dispatchers' orders.

(To Be Continued.)

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Theodore E. Lutz was born in Schuylkill county, Pa., April 6, 1872. He attended the common schools of that county while learning the blacksmith's trade, and at the age of nineteen he moved to Ohio. After working at his trade in various places for about a year, he entered the service of the Big Four, as a blacksmith in the interlocking gang, under Mr. C. A. Christofferson, now signal engineer of the Northern Pacific. After serving in various capacities in the signal department, in 1895 he was appointed signal supervisor of the Cleveland-Indianapolis division at Galion, which position he now holds.

# Paint for Iron and Steel

By Frank Neal.

[Read before the Detroit Engineering Society.]

Iron and steel paints have been the subject of some scientific study by both the consumer and paint manufacturer, but I am inclined at times to believe that very little is actually known yet as to what really is the best coating for iron. Without trying to review all the scientific work that has been done along this line, with which you are doubtless familiar, I will try to give you briefly some results of our own practical experience as paint manufacturers.

The old claim that linseed oil is the life of paint does not necessarily apply when we are considering iron coating. While linseed oil is a necessary ingredient, other elements are equally important, namely, the pigment to be used and some other vehicle to offset certain characteristics of the oil. In painting on wood we have a more or less absorbent surface, depending on the wood that is used, but on iron the paint has no absorbing surface into which the oil can penetrate and bind. The oil must make its own bond in such a way as to form a thin even coating not easily marred or scraped off. This cannot be done by the use of linseed oil alone. I have in mind the specification of a large railroad in this country that was drawn up by a very eminent chemist. The pigment was composed of 45 per cent carbonate of lead and 55 per cent pure carbon lampblack, and the vehicle was composed of about 90 per cent linseed oil, balance dryer. The specification called for not in excess of 15 per cent pigment and 85 per cent vehicle in the total. This paint was designed for use on steel freight cars. You know what extreme conditions these cars are subjected to and what the paint must stand if it has any protective value. Now I have made quite a number of carloads of this paint and naturally wished to know what it would do, so I made tests and, while this paint costs the railroad company about $1 per gallon, I have tested it against different paints which they could buy for not in excess of 75 cents per gallon that have proven vastly superior to it.

On several occasions I have gone into large buildings in course of construction for the purpose of examining the steel which was being erected and have found it coated with a film of oil paint which under a slight pressure of the finger could be shoved completely off the surface. Such paint is totally unfit for the purpose for which it is designed. I have often wondered that a great many more fatal accidents do not occur, owing to the slippery condition of this paint film under the feet of the man, sometimes many stories up in the air and mighty little between him and his Maker if he slip on this kind of paint. I wish to impress upon you that in buying paint for structural work great care should be exercised in selecting an article that will produce a film that will be firm under the feet of the man that you send away up in the air to erect the steel.

At Atlantic City the Society for Testing Materials is conducting a series of tests in connection with the United States government and the Paint Manufacturers' Association. These tests, while of importance, are not of much commercial value, for they are all made with practically one binding liquid and that raw linseed oil. It seems to me that in order to get results of practical value we must experiment not only on what pigment shall be used, but what vehicle or combination of vehicles, together with what pigments, produce the best paint for iron or steel.

About twelve years ago we had erected at our factory a large steel tank for linseed oil storage. At that time great claims were being made for graphite as a steel protective coating. Not very much was known at that time about painting iron, and we knew as little as any one else. It was decided to paint the tank with graphite, which was done, but it was black and all our buildings at that time were white. So in order to make it look right we put on three coats of white over the graphite. The following year we erected another tank of the same kind. When it came time to paint it we examined the old tank and were greatly surprised to find innumerable small blisters all over it which, when punctured, were found to be full of water, and the tank was very badly pitted. In order to save the tank it was necessary to remove every bit of that paint and clean the surface of rust, which was done at once. Then the problem of paint again arose. Another pigment had been discovered which was said to be a very fine preservative. This article was made up into paint of the accepted form and applied to the new tank. As a comparison we used for the old tank a mixture of red lead, linseed oil and turpentine. Before deciding on the proportions of this last formula, I made several experiments to determine just how much oil red lead would solidify. After determining this I found that something more was needed as a thinner. I decided, however, not to add more oil for a thinner, as would ordinarily be done. I decided that the thinner, to make a paint suitable for spreading, should be one that would evaporate, leaving the lead and oil to form their natural chemical compound, which is a cement almost as impervious to water as a combination of litharge and glycerine. This paint we applied to our old tank and then both tanks were coated with three coats of white to conform to our buildings. Since that time we have erected several other tanks, and in every case they have been coated with this red lead paint. The old tank which has been painted now over ten years was in good shape four years ago. We repainted it and all of our buildings, changing the color from white to brown, on account of the smoke which is so prevalent in Detroit. It is still in good shape. On the other hand, our second tank was found to be in bad condition four years ago, and we had to remove all the old paint. While the paint on this second tank had been on for seven years, the undercoat was still an imperfect, undried film, and easily peeled off to the iron as described above.

Now, I do not wish to give the impression that I think red lead is the only pigment for the protection of iron. The combination which I have described, unless protected by another pigment and more oil, will not stand up at all well as a final coat. When properly protected, however, it will be found to give excellent results. Neither do I wish to give a wrong impression as to my attitude regarding the use of linseed oil as a protective coating for iron. Linseed oil is one of our best friends in the paint trade as a vehicle or distributer of pigment for its protective qualities, and as a binder of the pigment to the surface to which it is being applied. But there is such a thing as getting too much linseed oil on iron, and when we do the end we have in view is defeated and we have an improper combination which the slightest bruise knocks off, exposing our iron to the ravages of the elements. Linseed oil under proper conditions will absorb oxygen from the air or from pigments with which it is mixed, forming a practically insoluble compound linoxin. If this linoxin has a sufficient amount of insoluble pigments in with it, we have something which, while not everlasting, is fairly satisfactory.

Now let us go a step further on the subject of linseed oil. This article, as it comes on the market today, seldom if ever has a chance to settle and age. As a result it is bound to have more or less soluble glutinous matter in its composition, which remains in it and goes into the paint, thus weakening the paint film to a greater or lesser extent. On the other hand, the progressive manufacturer takes a well-clarified oil and by the use of chemicals and heat all of these impurities are driven off and he has left only the valuable part of the oil which, when combined with proper pigments, produces a paint which is very much less susceptible to the ravages of the elements than the raw oil similarly combined.

I have known many cases where an oil, prepared as I have described, and thinned with one-half of that much-despised naphtha, has outworn the pure, raw linseed oil, both being mixed with the same amount and kind of pigment. Then, again, we have had good success in painting iron and steel with paint into which different proportions of hard fossil gums have been incorporated. We have also had some little success in the use of resin oil in connection with linseed oil, but only to a limited extent. So we always return to our oldest friend, linseed oil, whether it be in the raw form of commerce or scientifically treated. Without a doubt it stands supreme to date when properly handled.

And now to sum it all up, the best iron and steel paint I have been able to produce or have seen consists of linseed oil in connection with almost any pigment, providing enough volatile liquid is used to prevent the application of too much oil on to a non-absorbent surface. The point is that too much oil skins over on the surface so that the oil cannot absorb enough oxygen from the air to enable it to become that almost insoluble compound linoxin. Our experience has been and is today that in the painting of anything the oil, properly handled, restricted or supplemented where necessary, is the life of the paint. On certain woods too much oil cannot be used in the priming coat. On other wood the more oil used the worse the result. Some wood contains sap or resin to such an extent that it repels the oil, causing it all to lie upon the surface, forming no bond, and when aftercoats are applied which are less elastic, owing to their having more pigment in their composition, the expansion under heat or contraction from cold will cause this paint to peel or crack badly.

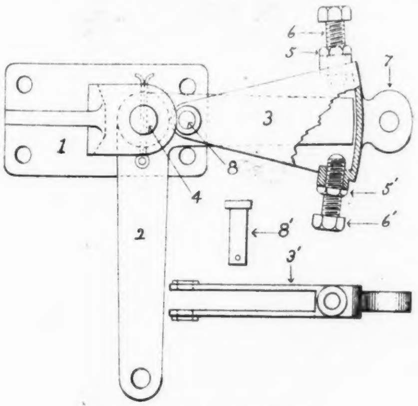
Painting on iron is somewhat similar to painting on sappy or resinous wood. In order to get satisfactory results the least possible amount of oil should be used in the priming coat, gradually increasing the percentage of oil and decreasing the percentage of pigment in succeeding coats, absolutely the reverse of what you would do were you painting white pine.

# With The Manufacturers

## The Lutz Crank Attachment

This device, the invention of Mr. T. E. Lutz, Galion, O., is made of the best malleable iron, and is designed to fit any crank arm used in connection with interlocking and signal apparatus. To apply the arm to an interlocking crank, 1½ inches of the end of one of the crank arms is cut off and the attachment is slipped over the remainder and fastened near the fulcrum or center pin of the crank with a small pin. The object of cutting off a portion of the crank arm is to retain the original length of arm, center to center. The device is designed to take up lost motion, due to wear. It may be used in any pike line and can be fitted to the crank arms by any workman with ordinary tools.

To install the "attachment" the lever in the interlocking machine is given from one to two inches more throw than is required to operate its unit. This extra throw is taken care of by the lateral play between the adjusting screws provided for making adjustment. The adjusting screws are 1 inch diameter with standard V thread, the end of the screws reduced in size



Lutz Crank Attachment.

to the depth of the threads for about one-quarter of an inch. This is done to avoid marring the threads when coming in contact with the end of crank. By the adoption of this attachment the switch adjustments, which are placed between the switch points, where workmen are compelled to risk themselves to make adjustments, can be eliminated.

While the attachment is not entirely inclosed, it is obstruction proof, inasmuch as cranks are usually placed some distance from the rail, or track, and considerably above ground level. This is not the case with the old style switch adjustment, as they are fastened to the center of switch rods, between two ties, lower than the base of the rail, a part of the roadbed first to collect obstructive matter. Its simplicity, durability and economy can thus be readily seen. This attachment is not limited to use on cranks operating switches and derails, but may be employed on cranks operating pipe connected signals, detector bars, or any other apparatus.

Tests of the "attachment" as to strength have been made and in each case it was found that the crank and not the attachment broke. The test in each case showed the break to occur between the small pin, used to fasten the attachment, and the fulcrum pin of the crank, at an average weight or pull of four thousand pounds.

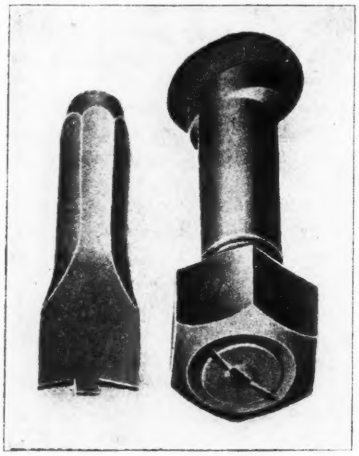
This device is protected by patent application, and preparations are now being made by Mr. Lutz to manufacture and put it on the market in addition to several other styles of adjusters now being made by him, cuts and descriptions of which were published in our February issue.

## The Clark Nut Lock

Serious damage is done by salt water drippings from refrigerator cars to the bolts on the tracks, as it soon rusts the end of the bolt that projects beyond and renders it impossible to remove the nut or tighten it. The Interlocking Nut & Bolt Co., of Pittsburg, Pa., manufacture the Clark nut lock, which, they claim, avoids difficulty from this source. In the application of this lock care is taken that the end of the bolt is just even with the outside of the nut, and the bolt being thus housed by the nut there is none of it exposed to the action of the salt water. No spring washers are used and the nut is brought tightly against the angle bar, so that practically no salt water can get between the nut and the bar to affect the thread on the inside of the nut. Hence, as none of the thread projects beyond the nut the bolt is protected from the salt water by this device. The makers have the following to say regarding their product:

"1. This lock is applied by slotting, and then expanding the end of the bolt, thus forcing the threads of the bolt firmly into the threads of the nut, and then forcing a portion of the nut into the slot in the bolt with a chisel especially designed for this purpose, thus firmly interlocking, first, the bolt into the nut, and then the nut into the bolt.

"2. The threads of the bolt being thus expanded tightly into the threads of the nut, increases the tensile strength of



The Clark Nut Lock.

the nut to equal the tensile strength of the head of the bolt, as well as forming a perfect lock, which prevents the nut from coming off with any amount of vibration.

"3. Expanding the bolt into the nut in the manner described above entirely overcomes the danger of stripping.

"4. The nut, coming in direct contact with the angle bar, gives a broad, smooth bearing surface to the nut, thereby reducing the wear between the nut and the bar to a minimum.

"5. In point of economy a great saving is made in the use of this lock, as the best results are obtained by locking, when the end of the bolt is even with the nut, thus saving at least ½ inch to 1 inch on each bolt, which effects a saving in material of 25 per cent to 50 per cent.

"6. The Clark nut lock can be removed as often as desired, and can be replaced without any trouble, and locked in the new position as firmly as in the first instance.

"7. In case of wear, or 'stretching' of the bolt, the nut can be tightened up and locked securely in the new location, which process can be repeated as often as the occasion may demand.

"8. Salt water drippings do not affect the Clark nut lock, as the bolt ends even with the nut, and is therefore entirely protected."

They will furnish a chemical analysis of the steel used in filling each order.

The following comparative statement of standard track bolts adopted by the Pere Marquette Ry. and standard track bolts adopted for use with the Clark nut lock, showing saving on each bolt, is furnished by the makers:

| Size of Rail | Standard Track Bolt used by Pere M. Ry. | Standard Track Bolt used with Clark Nut Lock | Saving on each Bolt by using Clark Nut Lock |
|---|---|---|---|
| 85 lb. | 4¾ in. | 4 5/16 in. | 7/16 in. |
| 75 lb. | 4½ | 3 11/16 | 9/16 |
| 70 lb. | 4 | 3 11/16 | 5/16 |
| 67 lb. | 3¾ | 3⅛ | 6/16 |
| 60 lb. | 3½ | 3 | 8/16 |
| 56 lb. | 3½ | 3 | 8/16 |
| 50 lb. | 3½ | 3 | 8/16 |
| 40 lb. | 2⅝ | 2⅝ | None |
| 35 lb. | 2⅝ | 2⅝ | None |

The device is illustrated herewith.

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A. McGill has been appointed roadmaster of the second division of the St. Louis, Brownsville & Mexico, succeeding W. F. Sparks, resigned to enter private business.

R. A. Clark.

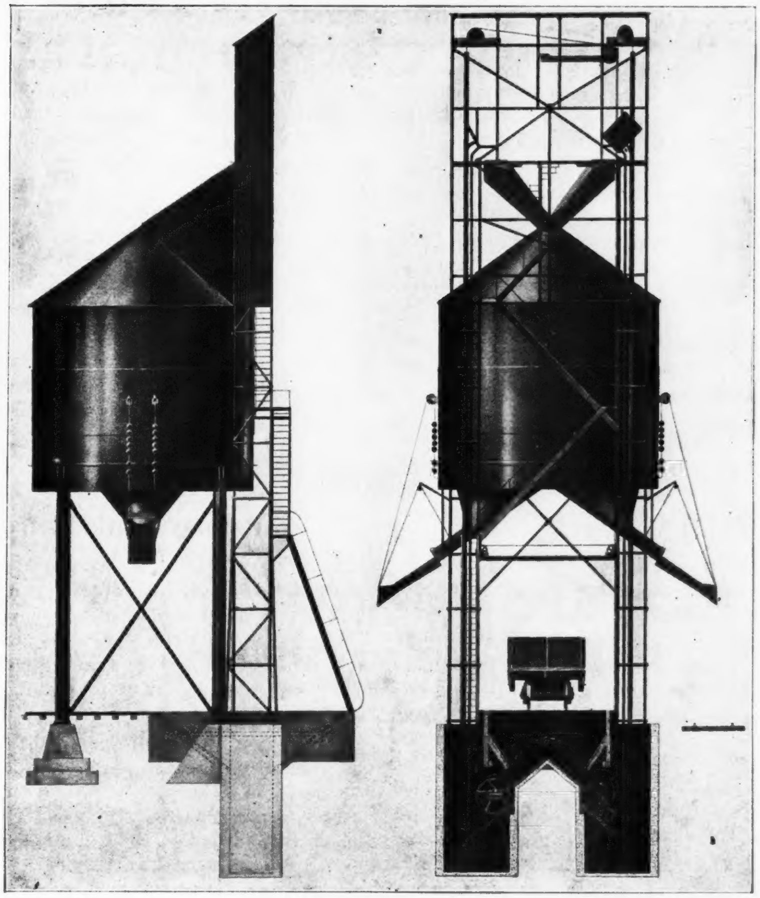
Mr. Lutz is well known as an inventor of interlocking apparatus. Among the most noted of his inventions are the "Lutz Adjuster," and the adjustable crank attachment. The former is made in six different styles, designed for pipe lines operating signals, locks and detector bars, switches and derails. The adjuster performs two functions, that of a turnbuckle and that of a switch adjustment. The adjustable crank attachment is a very simple device doing practically the same work as the apparatus first mentioned. A cut and description of this device will be found elsewhere in this issue. Mr. Lutz is the original inventor and joint patentee of the "Hayes Derail," but disposed of his interest to the Hayes Track Appliance Co.

Mr. Lutz is a member of the Railway Signal Association, Signal Appliance Association, and is the manufacturer of his late inventions.

T. E. Lutz.

C. D. Magner has been appointed division roadmaster of the Gulf, Colorado & Santa Fe, at Conroe, Tex., succeeding Samuel Lincoln, transferred.

C. D. Purdon has been appointed chief engineer of the St. Louis Southwestern, and W. T. Eaton, chief engineer of the St. Louis Southwestern of Texas, succeeding M. L. Lynch, retired from both companies.



Otto Coaling Station.

## Otto Coaling Station

The Otto Gas Engine Works, of Chicago, has produced a design of coaling station highly interesting in its various details and its method of operation. The design is based on a principle which involves the use of a bin or hopper at or near the ground level into which the loaded cars are dumped, machinery for elevating the coal in buckets from this hopper to a storage bin into which the contents of the buckets are discharged automatically, and means for permitting the coal to flow by gravity from the elevated storage to the tender of the locomotive.

The first feature met with is the receiving hopper into which the coal is dumped directly from the car. In the design illustrated this is placed underneath a track passing between the columns which support the elevated storage bin. The track crossing this hopper is supported by a pair of 20-in., 75-ft. I-beams, of 24-ft. span, providing an unobstructed opening to receive the contents of any kind of drop bottom or side dumping car. The sides of the hopper converge so as to cause the coal to flow in equal quantities through the bucket loading mechanism into the elevating buckets, which convey it to the storage bin above. A pit 8 ft. 4 ins. x 5 ft. 6 ins. is provided on each side of the receiving hopper and into this the buckets are lowered for filling. In accordance with the later practice of the builders, these pits and the hopper are built entirely of concrete and form, in part, the foundation upon which the superstructure is based.

The bucket filling mechanism consists essentially of two half cylinders made of ¼-in. steel plate and placed in a horizontal position in such relation to the discharge openings of the receiving hopper or to be automatically filled by gravity. Fastened to each cylinder head is an eccentrically mounted sheave around which a ½-in. cable makes a single turn and passes over a pair of idler sheaves. The ends of these cables are secured to the ends of a pair of horizontal bars, which are guided by the framework of the bucket-hoist in such manner that the descending bucket engages the bar, and by its weight, simultaneously operates the two measuring cylinders, dumping the contents of one into the bucket just descended and revolving the other to the filling position. Between the measuring cylinder and the bucket is an apron, which conducts coal from the former to the latter. This apron, which is pivoted near one end, is opened automatically by the weight of the coal which falls against it as the measuring cylinder discharges. The point of the apron extends a short distance over the edge of the bucket. By reason of this, when the bucket is lifted, the apron is tipped back into the closed position, and because of the counterbalance attached to the rear of the sideplates, it is held in that position until the measuring cylinder on that side again dumps coal against it and operates it as before.

It is not practicable to adjust the body of the measuring cylinder so close to the edge of the discharge from the receiving bin, as to prevent a certain amount of fine coal sifting through. This is taken care of by means of a plate over which the coal dust flows down to the apron, the rear edge of which is curved over to prevent the dust falling through into the pit. As the apron is tipped, whatever particles have sifted through are dumped with the coal into the bucket. The capacity of the cylinder in each case is just equal to that of the bucket, and since, during the filling of the bucket, the edge of the cylinder cuts through

the coal supply from the hopper above, only that amount of coal can flow into the bucket that has previously filled the cylinder. By this means a uniform loading of the buckets is obtained and no coal, however fine, can fall into the pit. The reason for mounting the sheaves eccentrically with respect to the axles of the cylinder is to effect a more perfect balance of the cylinder and to afford a greater leverage for the action of the cable. Thus it is seen that the bucket-filling mechanism is balanced, one side against the other, and also that its manipulation is not positive, wherein a very important feature of this device is involved. The value of this indirect action is made evident when an obstruction of any kind, such as a piece of timber, becomes lodged in either of the measuring cylinders. In such event, the bar descends only a portion of its full travel and prevents the descent of the bucket a like amount, which, of course, does not permit of its being filled. In the meantime the ascending bucket has been dumped and is returned for another load, whereupon the bucket on the side on which the obstruction has occurred is hoisted without load, making it at once evident to the operator from the behavior of the machinery, because of the reduced load (if he has not already detected it by the slackened cable), that attention to this part of the mechanism is required. To remove such an obstruction it is necessary only to allow the bucket on the side opposite to descend to the bottom of the pit, whereby the cylinder releases its hold on the obstruction and permits of its being removed.

The buckets are rectangular in section, are made of 3-16 and ¼-in. steel, in the 1, 1½ or the 2-ton sizes, as required. Each is provided with flange rollers running in the vertical angle iron guides, which, at the top, are bent in such manner as to dump the contents of the bucket into the storage bin by means of the continued haul on the hoisting rope. The hoisting cables are attached to the buckets through the medium of a bail pivoted near the bottom of the bucket. From here they pass over 36-in. sheaves at the top of the chute structure, thence down to sheaves near the base of the storage bin and to the drum of the hoisting machine. They are wound in opposite directions on the drum, and are securely fastened thereto. This provides for the counterbalance of the hoisting buckets, confining the load on the machinery to the actual hoisting of coal and to overcoming the friction of the mechanism.

The most radical departure from ordinary coaling station practice is seen in the form of storage bin that has lately been devised by this company. It consists of a steel tank 28 ft. in diameter, made of 5-16-in. steel and in external appearance is in every way similar to that of the ordinary water tank. Many advantages can be claimed for this type of construction, among which are its cost, being cheaper than concrete, though somewhat more expensive than wood, its compactness permits of its being placed in yards or elsewhere where space is limited, it is fireproof, and also more sightly than a similar structure of either concrete or wood. Inasmuch as the coal contained therein is continually settling toward the bottom, little danger of corrosion of the steel plates need be feared. Its capacity, normally about 300 tons, may be increased or diminished by varying its hight.

A specially designed connection permits the apron to swing in a lateral direction 2 ft. each side of its mid position. Since the apron is 3½ ft. in width, this gives a total lateral range over which coal may be distributed, of 7½ ft. An end-plate at the mouth of the apron deflects all coal downward, preventing its being thrown across and off the tender as is likely to occur when this precaution is not provided. The weight of the apron is counterpoised by a series of weights suspended on a pair of ⅜-in. cables passing over shrouded sheaves. A section of chain connects the cable to the dead point, which takes a portion of the load off the cables when the apron is raised, thus effecting a more perfect balance for its various positions, and reducing the effort required to operate it to a minimum.

The operating hoist may be driven in whatever manner is most convenient. At or near terminals or division points, a motor drive would doubtless be found desirable, while for isolated stations, the gas engine is well adapted. The mechanism of the hoist is such that as a bucket of coal reaches the top of the structure and is dumped, the clutch through which the drum is driven is automatically disengaged, and the brake is set on the drum, remaining so until the operator throws the control lever over, engaging the clutch that drives the drum in the opposite direction, whereupon the brake is released and the operation is continued with the other bucket. On one end of the drum shaft is carried a winch, provided for the purpose of spotting cars and removing them from over the receiving hopper. During this operation the drum is disengaged by means of a jaw-clutch provided for the purpose, the buckets remaining stationary until the car spotting operation is completed. The normal speed of the hoist is 75 ft. per minute, giving it a capacity of from 60 to 100 tons of coal per hour, depending on the hight to which the coal must be lifted and the size of the bucket used. The power requirements vary from 10 to 15 h. p., depending on the capacity of the plant.

## Pennsylvania Pension Fund

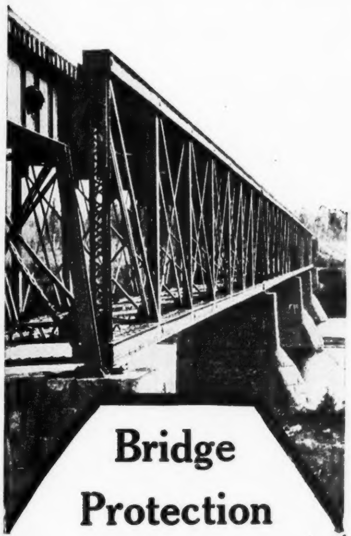
According to the regular monthly report of the relief department of the Pennsylvania railroad system, the sum of $177,386.24 was paid to members during the month of May, 1910. Of this amount, $120,513.10 represents the payments made on the lines east of Pittsburg and Erie, and $56,873.14 on the lines west. Since the establishment of the funds, a total of $28,469,890.15 has been paid out.

On the lines east of Pittsburg and Erie in the month of May, the payments in benefits to the families of members who died amounted to $42,056.25, while to members incapacitated for work they amounted to $78,456.85. The total payments on the lines east of Pittsburg since the relief was established in 1886 have amounted to $20,751,112.20.

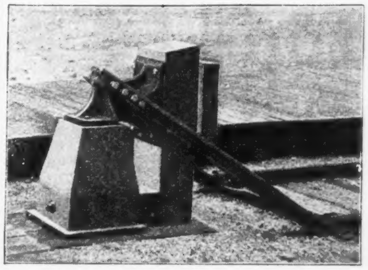
In May, the relief fund of the Pennsylvania lines west of Pittsburg paid out a total of $56,873.14, of which $25,436.24 were for the families of members who died, and $31,436.90 for members unable to work. The sum of $7,718,777.95 represents the total payments of the relief fund of the Pennsylvania lines west of Pittsburg since it was established in 1889.

The Isthmian Canal Commission has awarded to Hubbard & Co., of Pittsburg, the order for shovels and tools, basing their decision on quality.

John T. Wilson, district engineer of the Baltimore & Ohio, with jurisdiction over the territory between Philadelphia, Pa. and the Ohio river at Parkersburg, W. Va., and Wheeling, with office at Baltimore, Md., was educated at the Massachusetts Institute of Technology and began railway work as a rodman in 1886 on the Pittsburg & Lake Erie. About two years later he went to the engineering department of the Pennsylvania Railroad as a transitman, and was then appointed draftsman and later promoted to assistant engineer. He was appointed resident engineer of the Pittsburg & Western, now part of the Baltimore & Ohio, in December, 1897, and subsequently became engineer maintenance of way. In August, 1902, he was appointed resident engineer of the Baltimore & Ohio at Wheeling, W. Va., and division engineer two years later. In August, 1905, he was made assistant engineer, with office at Baltimore, Md., and while in that position was engaged in the work of rebuilding the old main line between Relay Station, Md., and Washington Junction. The large classification freight yard at Brunswick, Md., was built under his direction, as well as the double-track steel bridge over the Susquehanna river, which was opened in January of this year.

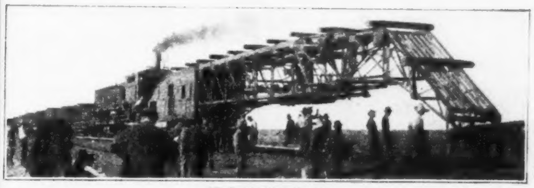






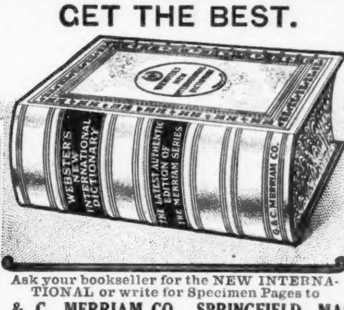












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